bulletin of
Duke University
1987-88

School of Forestry and
Environmental Studies

The information in this bulletin applies to the academic year 1987-88 and is accurate and current, to the extent possible, as of August 1986. The University reserves the right to change programs of study, academic requirements, teaching staff, the calendar, and other matters described herein without prior notice, in accordance with established procedures.

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School of Forestry and Environmental Studies Calendar*

1987

August
24 Orientation
25-26 Registration of new and nonregistered returning students
31 Fall semester classes begin

September
1 Drop/add begins
11 Drop/add ends

October
17-20 Fall break

November
9-10 Registration for spring semester, 1988
26-29 Thanksgiving recess

December
4 Fall semester classes end
5-13 Graduate reading period
14-19 Final examinations

1988

January
6 Registration of all new and nonregistered returning students
7 Spring semester classes begin
8 Drop/add begins
15 Drop/add ends

March
5-13 Spring break
28-29 Registration for fall semester, 1988, and summer, 1988

April
15 Spring semester classes end
16-24 Graduate reading period
25-30 Final examinations

May
8 Commencement

*The dates in this calendar are tentative and subject to change.

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To the Prospective Student

The School of Forestry and Environmental Studies, a professional-graduate school functioning within a great university, focuses its efforts on forestry, natural resources, and the environment. Its Master of Forestry degree is designed to prepare professional forest managers of the future in both the public and private sectors. Its Master of Environmental Management degree is intended for those who wish to prepare themselves in some aspect of the broader field of natural resources. The school offers concurrent degrees with the Fuqua School of Business and the Institute of Policy Sciences and Public Affairs. Its doctoral program is designed for those interested in teaching or in research in a university, branch of government, or industry.

We seek able students who are motivated to research and analyze complex natural resource and environmental problems. We accept undergraduates from many educational backgrounds. However, we expect that each degree candidate will become highly disciplined in some aspect of the analysis of resource problems during the period of study at Duke.

To complement our traditional modes of education, we have introduced several new educational programs during the past few years. A number of students participate in the Integrated Case Studies Program in Natural Resource Analysis and the Integrated Toxicology Program described in this bulletin. Our Senior Professional Program is designed to meet the needs of practicing professionals who wish to update practical skills or to pursue an advanced degree. Internships are available to qualified students. Supporting all of these educational programs are the research interests of an outstanding faculty committed to the advancement of knowledge concerning resources and the environment.

The following pages provide information about our degrees, programs of study, and research. We invite you to visit the Duke campus to meet our students, faculty, and professional staff, and to learn about our school first hand.

George F. Dutrow
Dean, School of Forestry and
Environmental Studies

General Information

Objectives

The School of Forestry and Environmental Studies pursues a broadly based program of research and education at the graduate level. Its programs are designed to educate professionals, scientists, and academicians to analyze a wide range of environmental and natural resource problems.

After nearly fifty years of forestry research and education at Duke, the school has shifted from a focus on woodland productivity and protection to a focus on ecosystem productivity and protection. The land and its associated components, including plant and animal communities, water, and air, are integral parts of the orientation of the school. The emphasis is on defining objectives for forest and natural resource management, understanding the interrelated constraints—physical, biological, ecological, economic, legal, and social—and devising and testing alternative management solutions. Indeed, problem analysis is the central focus of all programs of the school. The student will learn the capabilities and limitations of quantitative analysis and seek imaginative solutions for problems requiring a qualitative approach.

The school is particularly interested in the development of a holistic view of the environment and natural resources. This viewpoint requires the application of knowledge from the natural, social, and management sciences. Students are encouraged to integrate studies in natural resource science, systems science, economics, and policy in the pursuit of a particular program of study. The approach is first to identify problems, then to synthesize information, to develop critical analyses, and finally to plan and design solutions.

This approach is pursued by research, formal courses, seminars, field studies, and special conferences and symposia. Informal contact among students, faculty, alumni, and practicing professionals forms a strong part of the program. A number of academic and professional disciplines are represented on the faculty, and practicing professionals are frequently involved in teaching as well as in research. Several government career employees are usually in residence as adjunct faculty members.

The school periodically sponsors conferences and symposia on subjects of major interest and concern to persons involved in resource management. These offer current viewpoints of outstanding individuals concerned with various aspects of natural resources and the environment.

Programs are designed for students drawn from a wide variety of undergraduate backgrounds in the natural and social sciences and from programs in forestry, engineering, business, and environmental studies. The goal is to help all students acquire the basic technical skills, knowledge, insight, and methods of analysis for solving natural resource and environmental problems.

Because integrated management of natural resources is in the early stages of development in this country and abroad, the school is changing rapidly and extensively. These changes offer many opportunities to explore new areas of research and education, to sharpen the capacity to analyze environmental and resource problems, and to contribute to the development of new professions.

An essential ingredient in this period of changing orientation in the school is a high level of student participation. A special student committee advises the dean and faculty on curriculum content and structure, research programs, degree requirements, and other matters pertinent to the goals of the school. Students serve on most school committees, and they may attend faculty meetings. Students also participate regularly in the planning of major conferences and symposia. Within the limit of school resources, students are encouraged to travel to local and regional meetings of professional and scientific societies. These activities are considered to be an essential part of the educational process.

History

Duke University developed from Union Institute, a small school established in 1838 in Randolph County, North Carolina. The name was changed to Normal College in 1851, and in 1859, to Trinity College. The college was moved to Durham in 1892. With the establishment of the James B. Duke Indenture of Trust in 1924, Trinity College became Duke University. At the outset, the University developed around a core of undergraduate programs. Later the Graduate School and professional schools of Medicine, Nursing, Law, Engineering, Divinity, and Business Administration were added. In 1932, forestry instruction was offered for students of Trinity College, and in 1938 the School of Forestry was established as a graduate professional school under the direction of Dean Clarence F. Korstian. The Master of Forestry degree was offered initially and later the A.M., M.S., and Ph.D. were offered through the Graduate School. The school has been fully accredited by the Society of American Foresters since 1939.

Dr. Korstian joined the faculty in 1931 as the first director of the Duke Forest. Brought to Durham by Dr. William P. Few, president of Duke at the time, Dr. Korstian set out to develop a "demonstration and research forest" that would serve as a model for owners of small tracts of timber in the South. During this period and for a number of years to follow, research focused primarily on problems of culture, management, and utilization of the softwoods and hardwoods of southern forests.

During the 1930s the faculty of the school was gradually expanded to include a number of research foresters who made substantial contributions to forestry in the Southeast. William Maughan, who specialized in forest management, joined the faculty in 1931. In 1935, Theodore S. Coile, a specialist in forest soils, was added to the faculty. Ellwood S. Harrar, a wood technologist, and Francis X. Schumacher, widely known for his contribution to forest measurements, arrived at Duke in 1937. In 1939, the school rounded out its initial faculty with three distinguished scientists: Roy B. Thomson in economics, James A. Beal in entomology, and Albert E. Wackerman in forest utilization. This faculty established and brought early recognition to the school. Later, faculty were added in silviculture, pathology, physiology, ecology, and biometeorology.

The expanded faculty was soon responsible for shifting the emphasis from southern forestry to research and teaching of forestry with a national and international point of view. Consequently, graduates of the school have found employment in public agencies, forest industries, education, and research in all parts of the nation.

Growing national concern with natural resources and environmental problems led to a new teaching and research emphasis in the 1970s. A new program in natural resource ecology, focusing on ecologically based land use planning, was added to the

traditional forest science and management curriculum. In 1974 the name was changed to the School of Forestry and Environmental Studies and a new degree was added, the Master of Environmental Management.

Location

Duke University is situated on the outskirts of Durham, a city of over 100,000 inhabitants, in the central piedmont region of North Carolina. The Appalachian escarpment lies approximately 100 miles to the west of Durham and the coastal plain is but a short distance to the east. The school is thus ideally situated near areas of ecological and topographic diversity which offer many opportunities for recreation as well as study.

Piedmont North Carolina is characterized by a rolling, forested topography interspersed with small farms and rural communities in addition to the state's largest cities. The climax forests of the piedmont are hardwoods; however, human disturbance over a period of many years has resulted in the establishment of many forests of the native southern pines. It is in regions like piedmont North Carolina that many of the nonindustrial private forests of the United States are located. These forests are destined to provide much of the increase of wood and wood fiber to be needed by the United States in the twenty-first century.

The southern Appalachians are widely known for their unusual history, picturesque topography, and wide range of flora and fauna. Here the typical hardwood forests which dominate at lower elevations give way to forests of spruce and fir at higher elevations. These forests supply a variety of specialty woods for North Carolina furniture manufacturers and for other industries. The region's numerous recreation areas are widely used for hiking, fishing, skiing, and other outdoor activities.

The coastal plain of North Carolina, already well known for its agricultural production, is now being used extensively by many of the nation's forest industries for plantations of the native pines. The extent of the intensive forestry practices in the coastal plains of North Carolina and other southern states is unmatched elsewhere in the world.

Coastal wetlands and estuaries, now recognized as one of the nurseries of world fisheries, offer abundant and valuable natural resources. North Carolina's Outer Banks and the barrier islands of the other southeastern states serve as protection for these coastal waters. The rapidly increasing population and development in this region make proper management of its natural resources particularly important to the nation.

Because of the school's central location near these regions of vital ecological importance, students are afforded the opportunity to study many current environmental problems in the field. Both the opportunity and the challenge exist to analyze these pressing problems and to develop sound approaches to their management.

Facilities

The School of Forestry and Environmental Studies is housed in the south wing of the Biological Sciences Building on the West Campus. Laboratory and supporting facilities are provided for both teaching and research in all subject matter areas offered in the school. Classrooms and seminar rooms are available in the school and in other parts of the building. A clubroom, offices, general study space, and a microcomputer laboratory are provided for students.

Computer Facilities. Computing is provided at Duke by the Duke University Computation Center which maintains an IBM 3350 System Complex. The center is connected by high-speed microwave to the Triangle Universities Computation Center (TUCC), a regional computer network located in the Research Triangle Park. The computer equipment at TUCC includes an IBM 3081, an IBM 370 Model 168, and two small Hewlett-Packard 2000 Access computers. Students and faculty in the school

have immediate access to TUCC through facilities in the Biological Sciences Building. A medium-speed card reader/line printer terminal, keypunch units, and a cluster of interactive terminals are easily accessible. Microcomputer laboratories and extensive data processing services are available within the University.

Libraries. The combined university libraries, including the main Perkins Library and nine school libraries, contain over 3,300,000 volumes. About 150,000 volumes are added annually. Approximately 10,300 periodicals and over 166 newspapers are received. The Biology-Forestry Library, located in the Biological Sciences Building, contains about 125,000 volumes, and receives about 900 periodicals.

Greenhouses and the Phytotron. Adjoining the Biological Sciences Building are excellent facilities for biological investigations under controlled conditions. The phytotron contains fifty separately controlled growth chambers and greenhouses which can be used to grow plants under a variety of environmental conditions. The phytotron is one of few such facilities in the United States.

Research Triangle Park. Numerous industrial and governmental organizations have established research facilities in the Research Triangle Park, ten miles from the Duke campus. Government facilities include the National Environmental Research Center of the Environmental Protection Agency, the Forestry Sciences Laboratory of the United States Forest Service Southeastern Forest Experiment Station, and the National Institute of Environmental Health Sciences. These laboratories provide opportunities for student research and internships in some of the most advanced facilities in the nation.

Neighboring Universities. Through a reciprocal agreement, Duke students may supplement their education in forestry and environmental studies by taking courses in related fields at the University of North Carolina in Chapel Hill, North Carolina State University in Raleigh, and North Carolina Central University in Durham. Graduate students of Duke University and the University of North Carolina at Chapel Hill are granted library loan privileges in both universities.

The Duke Forest

The Duke Forest comprises approximately 8,300 acres of land in five major divisions and several smaller tracts. A ten-minute walk from campus will take one well into many parts of the Durham Division, and a network of roads and fire trails makes almost all areas of the forest easily accessible.

The forest lies primarily in Durham and Orange counties, near the eastern edge of the piedmont plateau, and supports a cross section of the woodlands found in the upper coastal plain and lower piedmont of the Southeast. A variety of timber types, plant species, soils, topography and past land use conditions are represented. Elevations range from 260 to 760 feet. Soils of the region are derived from such diverse parent materials as metamorphic rock of the Carolina slate formation, granite, Triassic sedimentary rock, and basic intrusives.

The Duke Forest, as it is known today, had its origins in the mid-1920s when the University administration bought many small farms and interspersed forest land as buffer areas for the main campus and as an investment for the future. The forest was placed under intensive management in 1931 by Dr. Clarence Korstian, its first director. In its early development, several basic objectives were emphasized: (1) demonstration of timber management techniques on a practical and economic basis, (2) development of an experimental forest for research in the sciences associated with timber growing, and (3) development of the area as an outdoor laboratory for students of forestry.

Modification of these early objectives has arisen, in part, through a greatly increased interest and dependence on the forest for research in the areas of zoology, botany, and ecology by faculty and students at Duke and neighboring universities.

Background information useful to researchers is provided by the forest; it covers such features as soils, topography, inventory, plantation, and cultural records as well as a bibliography of past and current studies. Current work on problems associated with developmental pressures at the urban-rural interface and integrated approaches to natural resource management have multiplied the forest's value and benefit as a resource.

Since 1976, the Duke Forest has been included in a nationwide network of research sites selected by the Institute of Ecology under a program sponsored by the National Science Foundation. These sites, designated as experimental ecological reserves, were selected to provide a wide range of conditions and habitat types for long-term scientific research in a multitude of disciplines.

The forest also serves in an educational and recreational capacity for residents of the Durham and Chapel Hill communities. Hiking, picnicking, jogging, and nature study are particularly popular pastimes.

This natural outdoor laboratory is an invaluable supplement to the instructional, research, and recreational facilities of the school, the University, and the region.

A comprehensive forest management plan, completed in 1981, provides a framework of basic guidelines and policies enabling effective utilization of the forest's potential. Development of the management plan was coordinated by a team of faculty, staff, and students representing a broad range of disciplines. Timber management, recreation, water quality, unique plant communities, historical and archaeological sites, and data management are a few of the criteria that were studied as part of the planning process. The plan concentrates on overlaying compatible uses of the forest in as many areas as possible. The completed document facilitates sound management and decision making, and it is flexible enough to allow adaptation to the changing needs and interests of all users of the forest.

The forest provides assistantships to several students in the school each year. Some of these are associated with research, others with the day-to-day operation and management of the forest.

The Faculty

The faculty of the School of Forestry and Environmental Studies specialize in diverse areas of natural resources and the environment. They are committed to excellence in teaching and to the development of research on current environmental issues facing the nation. A favorable faculty-student ratio insures small classes, individualized instruction, and careful supervision of independent study.

Highly qualified professionals from the United States Forest Service, forestry consulting firms, conservation organizations, and other areas of specialization serve as adjunct faculty members. Professors in botany, engineering, history, and marine science at Duke and the Department of City and Regional Planning at the University of North Carolina also hold joint appointments on the faculty. Scholars from foundations, private industry, and government service often visit the school to conduct conferences and symposia, to consult with faculty and students, and to teach special courses.

The faculty is engaged in a dynamic program of research, much of which is oriented toward the analysis of contemporary natural resource and environmental problems. Students are encouraged to assist in these projects to involve themselves in real world situations. Many of the continuing areas of faculty research are described in the faculty section of this bulletin. Some faculty members are also involved in the development of case studies, a new approach to graduate training in resource ecology and management.

The school enjoys close relationships with other professional schools and departments within the University as well as at neighboring institutions. Duke's de-

partments of botany and economics, the School of Engineering, and the Institute of Policy Sciences and Public Affairs, for example, offer courses which are highly complementary to forestry and environmental studies. Faculty from these and other departments and institutions actively cooperate in research projects and sit on the graduate committees of students in the school.

The Students

A typical entering class at the School of Forestry and Environmental Studies consists of approximately sixty professional students from diverse backgrounds and geographic areas. In an average class, 45 percent of the students are from the northeast United States and 30 percent are from the South. Approximately 20 percent come from the Midwest and 2 percent from the Far West. Foreign students usually make up about 3 percent of the entering class. One-third of the students are women. Ages of all students have ranged from twenty to fifty-two, although the majority are twenty-five and under.

Educational backgrounds of the professional students are equally varied. On the average, the majority (54 percent) have undergraduate majors in the natural sciences. A smaller number (19 percent) have majors in either forestry, environmental science or earth science. Approximately 5 percent majored in the social sciences and 6 percent in the humanities. An additional 9 percent have dual majors and 6 percent have advanced degrees.

Publications
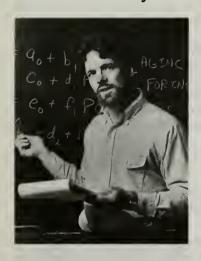
The Office of Resource and Environmental Publications serves as the center for publications issued by the School of Forestry and Environmental Studies. *FOREM* (an acronym for forestry and environmental management) is a news magazine that reflects all aspects of the school's current activities and achievements, with an emphasis on research. Published twice a year, it is mailed to alumni of the school and to other individuals and organizations throughout the United States upon request. Other regular publications include announcements of intensive courses, conferences, and special programs; a student resume book; and an annual research report. Technical bulletins and conference proceedings are published as part of a continuing series.

The office is under the direction of a publications specialist. Assistantships are offered to students who have photographic, journalistic, or artistic skills.

The Faculty

Resident Faculty

Ralph J. Alig, Ph.D., *Adjunct Assistant Professor;* B.S., Forest Production and Wood Technology, Purdue University; M.S., Forest Economics, University of Missouri; Ph.D., Forest Economics, Oregon State University.

An economist with the USDA Forest Service, Dr. Alig is interested in determinants of area changes for major land uses and forest cover types, methods for projecting associated area changes on a regional scale, and economic returns of forestland management alternatives. These are closely related areas of investigation that require consideration of the economics of land use and forestland management, landowner investment behavior and response to market and nonmarket incentives, and ecological processes of forest development and cover changes. Findings from the research pertaining to land use change, forestland management, and owner behavior provide a basis for developing long-range projection models that support forecasting of timber and other natural resource supplies at regional and national levels. A recent advance is the development of a model for the southern United States. This system has greatly improved the capability to systematically examine the impacts of land use and cover type changes on timber, range, wildlife, and water resources.

Future work will include examination of the relationship between international land use changes and forest area changes in the South as well as other regions of the United States. Dr. Alig also will be involved in the development and application of quantitative techniques for projecting forest type transitions in northern forest ecosystems, analysis of forest investment behavior in relation to government programs such as the Conservation Reserve Program of the 1985 Farm Bill, examination of the importance of risk in land use and management decisions by private landowners, and forest development on abandoned or idle crop and pasture land.

Daniel E. Binkley, Ph.D., *Assistant Professor;* B.S.F., Forest Management, Northern Arizona University; M.S., Forest Ecology, University of British Columbia; Ph.D., Forest Ecology and Soils, Oregon State University.

Dr. Binkley's research interests focus on forest productivity and nutrient cycling. The applied aspects of his research extend into forest nutrition management, including methods of predicting growth response to fertilization. Research into nutrient cycling processes includes studies using stable isotopes of nitrogen to trace nitrogen dynamics, and using natural acidification of soils by some tree species to investigate possible long-term impacts of acid deposition.

In one of his current major research projects, Dr. Binkley is studying atmospheric deposition and nutrient cycling in a loblolly pine ecosystem in the Duke Forest, part of an international network of research sites. The project involves detailed characterization of atmospheric chemistry, deposition, and nutrient cycles, with long-term monitoring to detect changes. He is also studying soil acidification by nitrogen-fixing red alders to quantify acid-generating processes in several forests in the Pacific Northwest. Construction of hydrogen ion budgets will allow key processes to be identified, and long-term changes in soil chemistry may give insights into long-term impacts of acid deposition. His research in the nitrogen dynamics of spruce/fir ecosystems examines patterns of nitrogen input, turnover, and loss in twenty-five high elevation forests in the southern Appalachian Mountains. The objective of this project is to provide information on the likely role of nitrogen cycling in the observed decline of these forests.

Alexander T. Davison, M.F., *Adjunct Assistant Professor;* B.S., Botany, M.F., Forest Entomology, Duke University.

Because his primary activity is consulting in forest land management, Professor Davison's research interests are in those areas that have application to that field. One of his primary interests is the use of aerial photographic interpretation to trace land use history, to facilitate forest management, such as in laying out harvesting roads in western North Carolina, and to increase the efficiency of forest inventory.

Further interests lie in small, private timberland ownerships, particularly in problems involving the enhancement of forestry and wildlife management.

For the past several years, Professor Davison has been involved in the establishment and use of the state park network, and has conducted a land use study of the area surrounding one of the North Carolina's scenic rivers.

Richard T. Di Giulio, Ph.D., *Assistant Professor;* B.A., University of Texas; M.S., Wildlife Management, Louisiana State University; Ph.D., Wildlife Biology, Virginia Polytechnic Institute and State University.

Dr. Di Giulio's research group in ecotoxicology is most concerned with biochemical responses of lower vertebrates to environmental contaminants. A major effort now getting under way involves the application of oxygen toxicity theory to the development of a sensitive methodology for detecting sublethal stress in aquatic animals, particularly fish, exposed to complex effluents. The underlying idea here is that a great number of important contaminants representing a variety of chemical structures are toxic at least in part due to their ability to generate free radical intermediates, including oxygen radicals. The group is also employing this approach to explore the biochemical mechanisms underlying the effects of air pollutants on forest vegetation.

In a related vein, Dr. Di Giulio is examining the mechanism of paraquat-induced teratogenesis in avian embryos. Additionally, he is performing collaborative research examining the comparative neurotoxicology of several insecticides in aquatic organisms, both vertebrates and invertebrates. Another area of research involves the study of trace metal dynamics in wetland ecosystems, particularly waterfowl food chains.

In summary, Dr. Di Giulio's research interests are in basic research relative to the entire field described as ecotoxicology. He believes that an important obstacle to solving ecotoxicological problems is the inadequacy of information concerning basic responses of lower organisms to contaminants and realistic contaminant mixtures. He is interested in supplying some of the needed information.

George F. Dutrow, Ph.D., *Professor;* B.S., General Science, M.F., Wood Technology, Ph.D., Forest Economics, Duke University.

Dr. Dutrow's research program is housed in the Southeastern Center for Forest Economics Research, with financial aid provided by the USDA Forest Service, and the United States Department of State, Agency for International Development. Three main areas are currently being pursued: (1) economic opportunities to increase national timber supplies; (2) economic efficiency of private and public programs of forestry assistance, and (3) economic consequences of risk and uncertainty in forestry. These research areas are being addressed cooperatively with scientists from industry, government, and other universities.

His personal research and research leadership are concentrated in two areas. First, he is engaged in addressing nationwide economic opportunities to increase forest productivity to meet national timber supply goals. This research assists government leaders and corporate executives to formulate effective policies and programs for United States forest resources.

Second, he is involved in selecting and directing a team of research economists to define private forestry enterprises in Latin America, Africa, and Asia. The purpose of this effort is to determine how forestry enterprises can be established in developing countries, become viable, and compete in world markets.

William F. Hyde, Ph.D., *Associate Professor*; A.B., International Relations, American University; M.A., Economics, M.S., Natural Resources, Ph.D., Resource Economics, University of Michigan.

One of Dr. Hyde's current research efforts is directed at the development of a problem analysis and methodology for investigation of the productivity of investments in forestry research programs in the South. As part of this objective, his research team will identify the levels of investments as well as who, differentiated geographically and by income class, bore the burden of the investments; and second, the marginal physical and value products of the investment as well as who received benefits.

Dr. Hyde is also involved in a study to show the economic theory of decision making under uncertainty as applied to long-term timber management. His research group is comparing the historical record of price variation in stumpage with measures of price variation in other industries to discover whether timber is more volatile than other products in the nation's economy. They will develop a model for stumpage price variation and test the model against price and quantity evidence. As part of the project, they will research and display the range for public agency risk aversion in general to provide a guide for an acceptable level of risk aversion in the model.

He is currently on leave in Bangkok, Thailand, to supervise Asia-wide social science research on common property, marginal lands, and upland forestry.

Benjamin A. Jayne, Ph.D., *Professor*; B.S.F., Forestry, University of Idaho; M.F., Ph.D., Forestry, Yale University.

Dr. Jayne's research interests are in the application of mathematical models and biophysical theory to a wide range of problems in forest resources. These range from the application of biophysical theory to the soil-plant-atmosphere system through the use of optimization and simulation in the management, harvesting, and manufacturing of the forest resource to the application of physical theory to the properties and behavior of composite and fiber materials manufactured from the forest resource.

Much of his research has emphasized wood and fiber composite systems and his most recent book deals with the mechanics of wood and wood composites. In the past few years, however, he has turned his attention to a broader scope of forest resources, in particular, management and harvesting strategies. Dr. Jayne is currently on leave.

Kenneth R. Knoerr, Ph.D., *Professor;* B.S.F., Forestry, University of Idaho; M.F., Forestry, Ph.D., Yale University.

Dr. Knoerr's research emphasizes investigations of the processes by which plants interact with the atmosphere. This research is approached from two perspectives. The first is the development of physical models for the plant-environment interaction. The second, in parallel with the modeling, is an extensive experimental effort to collect data on the gradients of radiation, wind, temperature, humidity, carbon dioxide and other environmental parameters that characterize the microclimate of forests and other vegetation.

His research group is involved in an intensive study of the characteristics of air flow within the forest. They are using sensitive sonic anemometers to obtain measurements for the development of improved models which will describe this flow and predict turbulent exchange within the forest and with the atmosphere above. These models will increase the understanding of the turbulent exchange of gases between forest vegetation and the atmosphere, the diffusion patterns of disease spores and pollen within the forest, and the mechanisms by which forests remove aerosols from the atmosphere.

Dr. Knoerr and his associates are also concerned with dry deposition as a portion of the acid rain problem and are studying the effectiveness of forest vegetation in removing sulfate, nitrate, and other aerosols from the atmosphere. Various estimates of wet deposition (in rainfall) and dry deposition indicate that they have similar orders of magnitude. However, while wet deposition can be accurately measured, methods of measuring dry deposition are quite uncertain. The research group is developing improved measurement techniques which are important both to improve estimates of total acid deposition and to evaluate the effects of deposited aerosols on vegetation.

Douglas A. MacKinnon, M.F., *Visiting Professor of Forest Management;* B.S., Industrial Administration, M.F., Industrial Forestry, Yale University.

Professor MacKinnon is southeastern regional director for George Banzhaf and Company, a forest resources consulting firm headquartered in Milwaukee, Wisconsin. A graduate of the Stanford University Executive Program, he spent fifteen years with several firms in the forest products industry, holding various positions in manufacturing, land management, long-range planning and capital budgeting. For eight years he was a member of the faculty at the University of Michigan, School of Forest Resources, and was chairman of the forest resources program during his last five years there. He has been active as a consultant in both the public and private sectors and is author of numerous reports and articles. The most recent of these deal with the fundamentals of capital investments, analysis of managerial systems, and timber sales accounting systems.

In addition to teaching courses in the business aspects of natural resources and forest resource management, Professor MacKinnon is responsible for organizing the Laird, Norton Distinguished Visitor Series which brings outstanding natural resource professionals to the school during the spring semester. His current research interests include planning in both the public and private forestry sectors, accounting systems for the public sector, appraisal and valuation of land and timber, return on investments in timber and timberland over time, and timber taxation.

Lynn A. Maguire, Ph.D., *Assistant Professor;* A.B., Biology, Harvard University; M.S., Resource Ecology, University of Michigan; Ph.D., Ecology, Utah State University.

The major area of Dr. Maguire's current research is the application of formal techniques for decision making under uncertainty and population modeling to the management of endangered species. Decision analysis provides a framework for integrating scientific information from ecological theory, stochastic population models, and empirical studies with economic and public policy considerations affecting the management of endangered species populations. Dr. Maguire and her students have used these methods to examine management strategies for grizzly bears, black-footed ferrets, Sumatran and Javan rhinos, tigers, and red-cockaded woodpeckers. In collaboration with zoo scientists, Dr. Maguire has studied alternatives for wild and captive management of endangered subspecies of tigers, rhinos, and lemurs, with the goal of generalizing the plans for managing subspecies populations.

Another area of her current research is the application of forest dynamics models to predict the impact of air pollutants on spruce-fir forests, part of a large, integrated forest research program. She and her students are using models of forest succession as a framework for hypothesizing effects of air pollutants on tree growth and mortality, and its eventual impact on forest composition and productivity.

Beyond these specific research projects, Dr. Maguire is interested in (1) the application of population dynamics, population genetics and ecological theory to the conservation of animal and plant populations; (2) the processes of competition and succession in managed and unmanaged forests; and (3) the use of quantitative methods, including statistics, decision analysis, and mathematical modeling, to integrate scientific information in resource management.

Carlos M. Marin, Ph.D., *Assistant Professor;* B.S., Civil Engineering, M.S., Environmental Science and Engineering, Rice University; S.M., Ph.D., Environmental Science and Engineering, Harvard University.

Dr. Marin's research interests lie in the water resource planning and management area, with particular emphasis on the role of prediction uncertainty in decision making. His current projects include (1) determination of optimal ca-

pacity expansion of water facilities under uncertainty, with a focus on the development of alternative pricing schemes; (2) contrasting the accuracy of short-term forecasts of water supply reliability with "black box" versus conceptually based models; (3) development of a decision analytic procedure for the management of hazardous waste sites; (4) mesoscale water resource assessment models in developing countries; and (5) development and testing of empirical Bayes procedures.

His future plans include projects to develop Bayes and empirical Bayes methods for parameter estimation in nonlinear, simultaneous equation, quantity/quality models. He is also interested in the use of spatial equilibrium models for evaluating interregional water trading rules, and the formulation of a sequential decision framework for the permitting of hazardous waste sites.

Ram Oren, Ph.D., *Assistant Professor;* B.S., Forest Resource Management, Humboldt State University; M.S., Ph.D., Forest Ecology, Oregon State University.

Dr. Oren's current research focuses on the interaction between individual trees and the stand in both the below- and above-ground compartments. He is studying the means by which the physical environment and competition affect the availability of light, water, and nutrients and, thus, the production of carbohydrates; and the allocation of carbohydrates under different limiting conditions to the growth of roots, stem, and crown. In the above-ground compartment, he is interested in canopy leaf area development in relation to tree growth and mortality, and wood production. His research seeks to identify key variables that indicate canopy competition and tree vigor, and can be used to separate normal stand dynamics from environmental stresses (such as drought or acid precipitation) in order to understand and predict effects on growth.

In more general terms, Dr. Oren is interested in using principles of plant physiology to explain whole-plant ecological phenomena, such as tree and stand vigor and their responses to acute pertubations or low-level continuous stresses.

Peter J. Parks, Ph.D., *Assistant Professor;* B.S., Forest Management, Oregon State University; M.S., Forest Economics, Ph.D., Resource Economics, University of California, Berkeley.

Dr. Park's research interests are in the application of microeconomic theory and econometrics to natural resource problems. Recent projects concern biometric and econometric modeling of forest resource supplies. Much of this has been for
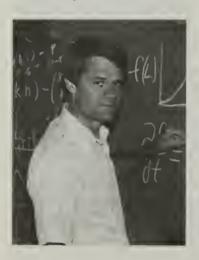
the USDA Forest Service to aid in national renewable resource supply assessments and the formulation of forest policy. Several of the studies examine allocation of land to resource production in different areas of the United States. Two projects to be completed in the future involve rural employment stability in the lumber and wood products industry and the role of economic incentives and uncertainty in land use decisions.

The first is a comparative study of the northwestern and southeastern regions of the United States designed (1) to quantify the influence of differences in regional timber economies on employment stability in the two regions, (2) to quantify the influence of public timber harvest policies on employment stability, (3) to determine whether employment in the lumber and wood products sector is less stable than in other industries, and (4) to quantify the contribution of lumber and wood products employment stability to the overall stability of rural employment.

The second is a study of land use changes in western states designed (1) to quantify the effect of land use controls on conversion of forestland to other uses, (2) to quantify the effect of uncertainty in predicting returns to alternative uses on land use decisions, and (3) to compare the influence of land use controls and uncertainty with that of economic incentives such as increased returns.

Kenneth H. Reckhow, Ph.D., *Associate Professor;* B.S., Engineering Physics, Cornell University; M.S., Ph.D., Environmental Science and Engineering, Harvard University.

Dr. Reckhow's research activities have focused on the development, evaluation, and application of models for the management of water quality. In particular, he is interested in the effect of uncertainty on model specification, parameter estimation, and model applications. Recent work has expanded this theme to consider the effect of scientific uncertainties on water quality decision making.

Among the problems that Dr. Reckhow's research group has examined are lake eutrophication, toxic substances, and acid rain. Past work on eutrophication has centered on the development and evaluation of empirical models, estimation of prediction uncertainty using first order error analysis and Monte Carlo simulation, and a decision analytic approach to lake management. Work soon to be initiated will be concerned with errors-in-variables and parameter identification in simultaneous equations models.

A past major research activity was the development of a decision (risk) analytic framework for the management of toxic substances in aquatic systems. Dr. Reckhow and his associates applied the framework to the problem of PCB management in the Lake Michigan watershed. This effort included work on a simulation model, uncertainty analysis and multiattribute utility theory.

Dr. Reckhow and his students have been working on an empirical model for the prediction of the probability of fish absence as a function of acid rain chemistry in United States lakes. This is part of a comprehensive effort to model the emissions, transport, and effects of acid rain for the purpose of policy evaluation at the national level. He expects to work on the aquatic effects of acid rain for the next two years, with an emphasis on error analysis, model specification, and prediction.

Curtis J. Richardson, Ph.D., *Associate Professor;* B.S., Biology, State University of New York at Cortland; Ph.D., Ecology, University of Tennessee.

Dr. Richardson's research interests in ecology are centered on long-term ecosystem response to large scale perturbations such as acid rain, toxic materials, flooding, or nutrient additions. He has specific interests in such internal ecosystem processes as primary productivity and phosphorus nutrient dynamics, and the effects of environmental stress on plant metabolism and growth. Major research just completed focused on Michigan wetlands as nutrient filters. The central hypothesis being tested was that wetlands ecosystems function as nutrient traps and this reduces downstream eutrophication in lakes and streams. Radioactive phosphorus was used to determine the rates of movement, storage, uptake and losses for this limiting nutrient.

His current research activities include: (1) the development of bioassay techniques to predict the potential stress effects of acid rain and ozone on spruce, fir, and loblolly pine physiology; (2) heavy metal, sorption storage and removal from drained pocosin peatlands; (3) wetland development trends in the southeastern United States; (4) aluminum toxicity and plant growth in bauxite residues; and (5) analysis of southeastern swamps as nutrient sinks.

Jack P. Royer, Ph.D., *Assistant Professor;* B.S., Forestry, Pennsylvania State University; M.S., Public Affairs, American University; Ph.D., Natural Resources, Cornell University.

Dr. Royer's primary area of interest is natural resource policy, in particular, the political, legal, and social dimensions of forest land, and water resource issues. His interests and research extend to institutional change, legislative and administrative processes, and alternative market and policy mechanisms for allocating natural resources.

Recently, his research has examined the relative importance of market and policy influences on the forestry investment decisions of southern landowners. Using logistical regression models and survey data, Dr. Royer has developed explanatory models of landowner behavior that isolate the effects of prices, costs, the reforestation tax credit and amortization, public cost-sharing, and technical

assistance on reforestation decisions. A goal of his current research is to develop predictive models that can be used to assess the effects of alternative market and policy influences on future supplies of timber and other forest resources. In other research he has explored patterns of land use change on flood plains and the attitudes of individuals and public officials toward nonstructural means of reducing flood losses.

Dr. Royer's longer term research interests lie in the development of more refined probability models of landowner behavior and the application of qualitative response models to other land management decisions, the voting behavior of legislatures, and the administrative choices of public officials.

William J. Stambaugh, Ph.D., *Professor;* B.S., Forestry, M.S., Forestry, Pennsylvania State University; Ph.D., Forest Pathology, Yale University.

By way of training, experience, and a continuing interest in forest pathology in general, Dr. Stambaugh's research orientation has focused on (1) the ecology of soil microorganisms with emphasis on mycorrhizae and root diseases of trees, (2) identification and evaluation of biocontrol systems in forest disease management, and (3) epidemiological analysis of forest pest management systems.

Soil microbiology, like so many fields of research, is characterized by a rapidly expanding literature base. Dr. Stambaugh's course in microbiology of forest soils, therefore, is research oriented to insure periodic updating of topics that bear on rhizosphere interactions, whether pathogenic or symbiotic. This has been the spark that has ignited a number of graduate dissertations dealing with mycorrhizal biology and the infection process of specific root-decaying fungi.

Tree root diseases have also been examined with regards to the biocontrol potential of saprophytic competitors for rootwood substrate and endomycorrhizal protection of nursery-grown hardwoods against root rot. Most recently, the aboveground system of hypovirulence in the chestnut blight fungus has been evaluated as a biocontrol mechanism for chestnut sprout survival.

The population dynamics of forest pests, primarily fungi and insects, is recognized as the key to development of an integrated approach to forest pest management. Dr. Stambaugh's course on this subject helps to identify research needs in this context with the potential for implementing analysis of multi-pest systems on the Duke Forest. The ultimate goal of this work is to attain predictive accuracy in identifying pest hazard situations on an operational planning basis.

James G. Yoho, Ph.D., *Professor of the Practice of Forest Investment;* B.S.F., University of Georgia; M.S., Forest Economics, State University of New York; Ph.D., Resource Economics, Michigan State University.

Dr. Yoho's research interests include most of the business aspects of private forestry and the forest products industry, particularly the strategic planning, management, and business policy phases. More specifically, this includes such subject areas as forest investment, finance, and taxation, plus marketing and international trade in forest products.

These topical areas closely parallel his many years of academic, research, and business experience, both domestic and international. Moreover, they are also areas of critical and timely concern to most individuals and firms in the private sector of the forest economy of the United States and much of the world as well. Economic conditions have changed drastically in this country and throughout the world since the initiation of most private forestry business and investment activity. This has resulted in a multitude of critical problems that must be solved if the health and vigor of the private sector of the forest economy is to be sustained.

Nonresident Faculty

William R. Bentley, Ph.D., *Adjunct Professor;* B.S., Forestry, University of California, Berkeley; M.F., Forest Economics and Management, University of Michigan; Ph.D., Agricultural Economics, University of California, Berkeley.
Dr. Bentley's current research interests are in agroforestry methodology and design, social forestry economics and policy, and timber supply and demand. He is senior program officer with Winrock International Institute for Agricultural Development.

Stephen G. Boyce, Ph.D., *Adjunct Professor;* B.S., M.S., Forestry, Ph.D., Plant Ecology, North Carolina State University.
Dr. Boyce's current research interests are timber production in relation to all forest benefits, and ecosystem dynamics and silviculture to provide forest benefits in the context of social, economic, and political forces. Chief ecologist, retired, with the USDA Forest Service Southeastern Forest Experiment Station, he has pioneered in the development and application of systems approaches to forest planning, management, and research.

Norman L. Christensen, Jr., Ph.D., *Associate Professor;* B.A., M.A., Biology, California State University, Fresno; Ph.D., Biology, University of California, Santa Barbara.
Dr. Christensen's current research interests are the effects of disturbance on the structure, function, and development of plant populations and communities, in particular, patterns of forest development following cropland abandonment as these are affected by environment, stand history, and patterns of seed rain. His research on the southeastern coastal plain is focused on a comparative study of biogeochemical and community responses to varying fire regimes. Dr. Christensen is associate professor in the Duke University botany department.

William K. Condrell, J.D., *Adjunct Professor;* B.S., Industrial Economics, Yale University; S.M., Business and Engineering Administration, Massachusetts Institute of Technology; J.D., Harvard University.
Professor Condrell's major research interest is the income, estate and gift, and property taxation of timber. He has specialized in work with tax systems which maximize timber growth and effective forest utilization from the viewpoint of both the national interest and timber ownerships of all sizes. At present, he is a partner in Steptoe and Johnson, attorneys, in Washington, D.C.

Michael P. Dieter, Ph.D., *Adjunct Professor;* B.S., University of Notre Dame; M.A., Ph.D., Zoology, University of Missouri.
Dr. Dieter is a physiologist with the National Toxicology Program of the National Institute of Environmental Health Sciences. His research interests lie in the area of environmental toxicology of metals, mammalian toxicology and carcinogenesis, and cellular biochemistry and physiology.

Robert G. Healy, Ph.D., *Adjunct Associate Professor;* B.A., Economics and English, M.A., Ph.D., Economics, University of California, Los Angeles.
A senior associate with The Conservation Foundation in Washington, D.C., Dr. Healy conducts and manages research with emphasis on natural resources, land-use and environmental regulation, and the economic effects of public policies. His current research interests are environmental management in Latin America, the international context for United States agriculture and forestry, and rural settlement patterns and forest management in the South.

Milton S. Heath, Jr., J.D., *Adjunct Professor;* A.B., Harvard University; LL.B., J.D., Columbia University.

Dr. Heath specializes in environmental and natural resource law and administration, and the legislative and other governmental aspects of resource development. He is a member of the Institute of Government faculty at the University of North Carolina at Chapel Hill.

William R. Sizemore, Ph.D., *Adjunct Professor;* B.S., Forestry, Louisiana State University; M.F., Duke University; Ph.D., Forestry, University of Georgia.

Dr. Sizemore is a principal in Sizemore and Sizemore, Inc., a consulting firm in Tallassee, Alabama, offering forest appraisal, analysis, and management services. His current research interests concern the impact of all types of taxes on forest landowners, industrial and nonindustrial. In the field of federal taxation, the combined effects of income and estate taxation are of special interest. He also has helped develop management information systems for forest operations.

Harold Karl Steen, Ph.D., *Adjunct Professor;* B.S., Forestry, M.F., Ph.D., History of Conservation, University of Washington.

Dr. Steen's current research interests are the political and economic development of modern forestry concepts and policies, and the history of conservation and land use as related to current forest land issues. He is director of the Forest History Society at Duke University.

P. Aarne Vesilind, Ph.D., *Professor;* B.S., M.S., Civil Engineering, Lehigh University; M.S., Sanitary Engineering, Ph.D., Engineering, University of North Carolina at Chapel Hill.

A professor in Duke University's School of Engineering, Dr. Vesilind is interested in research concerning wastewater and sludge management and disposal, and the development of solutions to solid waste and resource recovery problems.

Visiting Instructors

William H. Banzhaf, B.S.F., University of Michigan; *George Banzhaf and Company, Forest Management Consultants*

John Busterud, J.D., Yale University; *Attorney and Environmental Consultant, Palo Alto, California*

Steven C. Chapra, Ph.D., University of Michigan; *University of Colorado*

Mahlon Easterling, M.S., Columbia University; *Engineering Consultant, Durham, North Carolina*

Theodore Howard, Ph.D., Oregon State University; *Department of Forest Resources, University of New Hampshire*

George H. Mason, M.F., Duke University; *The Travelers Insurance Companies*

Clark Row, Ph.D., Tulane University; *Institute for Forest Analysis, Planning and Policy*

J. Michael Vasievich, Ph.D., Duke University; *USDA Forest Service*

Faculty Emeriti

Roger F. Anderson, Ph.D., *Professor Emeritus*

Leon Edward Chaiken, M.F., *Professor Emeritus*

Paul Jackson Kramer, Ph.D., *James B. Duke Professor Emeritus*

James Granville Osborne, B.S., *Professor Emeritus*

Degrees

Degrees

Duke University offers professional and research degree programs in forestry and environmental studies. Study can be pursued for a Master of Forestry (M.F.) or Master of Environmental Management (M.E.M.) degree in the School of Forestry and Environmental Studies, or for a Master of Science, Master of Arts, or Ph.D. degree in the Department of Forestry and Environmental Studies of the Graduate School.

The degrees offered through the School of Forestry and Environmental Studies (M.F. and M.E.M.) are professional degrees. They are intended mainly to provide students with the education and experience for careers in resource management.

The Master of Forestry degree concentrates on forest and associated resources, including woodlands, water, wildlife, and recreation, and their management from an ecological and economic point of view. The graduate with an M.F. degree is qualified for employment as a professional forester in an administrative, staff, or field position with federal or state agencies, forest industries, and other organizations concerned with forest and land management. The M.E.M. considers natural resources in a broader context. The basic objective of this degree is to develop expertise in planning and administering the management of the natural environment for maximum human benefits with minimum deterioration of ecosystem stability.

The Forest Resource Management program is offered under the M.F. degree. The remaining three programs of study—Resource Ecology, Water and Air Resources, and Resource Economics and Policy—are offered under either the M.E.M. or M.F. degree, depending upon the student's interests. In addition, students have the option of designing an individually structured program of study under either degree, with the approval of the faculty council.

Students planning careers primarily in teaching and research are urged to follow a course of study in the Graduate School. The Graduate School degrees (M.S., A.M., Ph.D.) are appropriate for the student who wishes to concentrate on a particular area of research in resource science, systems science, or policy.

Requirements for the Professional Degrees

A total of 60 units is required for either the Master of Forestry (M.F.) or the Master of Environmental Management (M.E.M.) degree. Although a student may fulfill part of the degree requirements through an internship or independent study off campus, he or she must complete at least 30 units and spend a minimum of two semesters in residence.

Students' programs consist of a combination of regular courses, independent projects, and seminars. A master's project of at least 4 but not more than 8 units is required of all students. Course work in other departments of the University and at nearby institutions is available to strengthen students' education in special areas.

A full semester load is 15 units, which should ordinarily consist of a combination of regular courses independent projects, and the master's project for not more than 13 units, plus 2 units of seminars. Not more than four regular courses can be taken in a semester. Permission of the dean is required to take more than 15 or fewer than 9 units in a semester.

As students progress in their programs, they are expected to devote an increasing amount of time to the master's project and to register for more independent project units in a semester. Thus, the student should plan to take fewer units of regular courses during the latter semesters of study.

REDUCTION IN DEGREE REQUIREMENTS

Students who have an undergraduate degree in forestry or environmental studies may earn either a Master of Forestry or Master of Environmental Management degree with only 30 units of credit. The undergraduate degree must have been received either from an accredited forestry school (for M.F. candidates) or from an approved curriculum in environmental science or environmental engineering, as judged by the faculty of the student's proposed program of study for the M.E.M. degree. In evaluating the student's credentials for admission with a reduction in credit requirements, special consideration will be given to professional experience. The student must spend a minimum of two semesters in residence. However, students who qualify for admission through the Senior Professional Program, described in a separate chapter in this bulletin, may reduce the residence requirement.

CONCURRENT DEGREES

Students desiring to earn both an M.F. and an M.E.M. degree can do so by planning their courses appropriately. The requirements for earning both degrees are as follows:

1. The student must qualify for either an M.F. or M.E.M. degree by earning 60 units of credit under the requirements set forth above.
2. For the second degree, the student must complete an additional 30 units of study composed of courses which would normally be accepted toward the second degree. Two semesters in residence are required.

Determination of eligibility for the degrees will be made on an individual basis and will consider the educational background and objectives of the student.

Master of Business Administration. The techniques of management science are applied with increasing frequency in the management of natural resources, and they are also now commonly used in the analysis of environmental problems. To integrate training in these management techniques more effectively into the curriculum, the School of Forestry and Environmental Studies has developed a cooperative arrangement with Duke's Fuqua School of Business. Three years of study are required to earn the combined degrees of Master of Forestry/Master of Business Administration or Master of Environmental Management/Master of Business Administration. Degree requirements in the School of Forestry and Environmental Studies are determined by the faculty council. Normally at least 45 units of credit within the school are required to receive the M.F. or M.E.M. degree. A typical program sequence would involve spending the first year in the School of Forestry and Environmental Studies followed by a year in the Fuqua School of Business and concluding with the final year in either school with elective work in the other.

These concurrent degrees stress concepts, analytical reasoning, and the basic methodologies of management science, while providing the student with a knowledge of current problems in the natural resource industries. Managerial economics, resource economics, organization theory and management, accounting, information and control, resource management, the legal environment, and public policy aspects of resource industries form a substantial component of each degree.

Because of the academic demands of these degrees, those entering without the necessary analytical skills or life science background may be required to take additional work beyond that specified.

Students who wish to undertake both the Master of Forestry or Master of Environmental Management and Master of Business Administration degrees must apply to and be accepted by each of the respective schools. For information on the Master of Business Administration degree, the prospective student should write to the Fuqua School of Business, Admissions Office, Duke University, Durham, North Carolina 27706.

Master of Arts in Public Policy Sciences. As issues concerning natural resources and the environment have become of increasing significance to the nation, there has developed a corresponding need for well-trained policy analysts who can provide timely and appropriate information and analysis to resource policy makers. To meet this need a unique concurrent degree has been developed in cooperation with the Institute of Policy Sciences and Public Affairs. Students pursue a Master of Forestry or Master of Environmental Management degree and a Master of Arts degree in public policy sciences. Doctoral candidates in forestry and environmental studies are also eligible to undertake the Master of Arts in public policy sciences.

The concurrent degree normally takes two and one-half years to complete. The first year is devoted to study in the School of Forestry and Environmental Studies, and the second year is spent in the Institute of Policy Sciences and Public Affairs. The final semester involves work in both areas. Degree requirements in the School of Forestry and Environmental Studies are determined by the faculty council. Normally, at least 45 units of credit within the school are required to receive the M.F. or M.E.M. degree. A summer internship with a resource or environmental agency, or with a related legislative, judicial, or interest group, is recommended.

This degree provides training in the politics and economics of resource and environmental policy making. Emphasis is placed on understanding the social and political forces involved, developing facility with quantitative and logical methods of forecasting, and evaluating policy consequences. Knowledge of the uses and limitations of policy analysis, and an awareness of the ethical dimensions of policy choice are also stressed.

Students must apply to and be accepted by both the School of Forestry and Environmental Studies and the institute. For detailed information on the policy sciences degree, write to Director of Graduate Studies, Institute of Policy Sciences and Public Affairs, Duke University, Durham, North Carolina 27706.

Other Concurrent Degrees. With the special permission of the faculty council and the dean of the School of Forestry and Environmental Studies, students are permitted, on an individual basis, to establish concurrent degree programs with certified graduate degree programs either within or outside of Duke University. In the past, students have designed such programs with law schools, business schools, and graduate engineering programs. As with the other concurrent degrees, the student must be enrolled in the Master of Forestry or Master of Environmental Management degree program for 45 units of credit and in residence for at least one full year.

To gain acceptance of a specially designed concurrent degree, the student must show an official acceptance from another certified graduate degree program. In order

to receive the M.F. or M.E.M. degree, the student must have completed 45 units of credit, the master's project, all program area requirements, and at least one full year of study in the other degree program (with an official transcript of work completed). For additional information concerning special concurrent degrees, applicants should consult the Director of Admissions.

Degrees in the Graduate School

In addition to the professional degrees (M.F. and M.E.M.) described earlier, Duke University offers the Master of Arts (A.M.), Master of Science (M.S.), and Doctor of Philosophy (Ph.D.) degrees in appropriate areas of forestry and environmental studies. These degrees are administered by the Graduate School of the University; however, the bulk of the instruction, research, and advising connected with them takes place in the School of Forestry and Environmental Studies. For administrative purposes, qualified faculty members of the School of Forestry and Environmental Studies comprise the faculty of the Department of Forestry and Environmental Studies of the Graduate School.

Degrees in the Graduate School are appropriate for students desiring to concentrate their study and research within a well-defined area of forestry or environmental studies. Students usually pursue fewer and more advanced topics to a greater depth than do students in professional degree programs. Thus, study in the Graduate School is more appropriate for students preparing for careers in teaching or research in specialized areas, while the broader approach characterizing professional education is more appropriate for students preferring careers in resource management.

Graduate School students emphasize research as major parts of their degree programs. An active research program is a vital component of the School of Forestry and Environmental Studies, and most of the research projects in the school utilize graduate students as research assistants.

Qualification of Students. Students seeking admission to the Graduate School must have received an A.B. or B.S. degree (or the equivalent in the case of foreign students) from an accredited institution. Usually the student should have majored in the area of intended graduate study or one closely related to it. Some work in science and mathematics is essential; however, the total undergraduate education should be well-rounded. Because research is such an integral part of graduate education and of the school's mission, the student's undergraduate record must evidence the capability and motivation to carry out independent study and research at an advanced level.

Policy and Procedures. Policy and procedures for admission, general requirements for degrees, registration, and academic regulations are given in detail in the bulletin of the Graduate School and are not repeated here. In general, procedures, requirements, and regulations are similar in the Graduate School and in the School of Forestry and Environmental Studies. Some differences are noted below.

Admission. Applications for admission to A.M., M.S., and Ph.D. degree programs in forestry and environmental studies should be obtained from and returned to the dean of the Graduate School, Duke University, Durham, North Carolina 27706. However, inquiries about programs of study and research should be sent to the director of graduate studies, School of Forestry and Environmental Studies. On request, the director of graduate studies will arrange to have application materials sent to the applicant.

All applicants for degrees in the Graduate School will have their files screened by the faculty of the Department of Forestry and Environmental Studies of the Graduate School. One of the faculty members must accept responsibility for advising the applicant before admission can be offered.

GENERAL REQUIREMENTS FOR THE MASTER'S DEGREES

Residence Requirements. Candidates for A.M. or M.S. degrees must spend, as a minimum, one full academic year (two successive semesters), or its equivalent in summer sessions, in residence at Duke University. Thirty units of graduate credit constitute minimum enrollment for a master's degree. Additional time to complete course and research requirements is frequently necessary.

Transfer of Graduate Credits. A maximum of 6 units of credit may be transferred for graduate courses completed at other institutions. Consult the bulletin of the Graduate School for details.

The Thesis. A thesis is required of A.M. and M.S. degree candidates. The thesis must indicate the student's ability to collect, arrange, interpret, and report pertinent material on a research problem. Although a publishable document is not required, the thesis must be written in an acceptable style and should exhibit the student's competence in scholarly procedures.

The Examining Committee and the Examination. The faculty member who directs the student's program recommends an examining committee composed of himself and two other members of the graduate faculty, one of whom usually must be from a department other than forestry and environmental studies. The committee conducts an examination based on the student's general program and the thesis.

Language Requirements. There is no language requirement for A.M. or M.S. degree candidates in the Department of Forestry and Environmental Studies.

Major and Related Subjects. The student must present acceptable grades for a minimum of 24 units in graduate courses. Of these, at least 12 units must be in the Department of Forestry and Environmental Studies. A minimum of 6 units must be in a minor subject or in related fields approved by the department and by the dean of the Graduate School. A maximum of 6 units may be earned by submission of an approved thesis.

GENERAL REQUIREMENTS FOR THE DOCTOR OF PHILOSOPHY DEGREE

The Ph.D. is a research degree. Although course work is a necessary part of the student's program, the mere accumulation of course credits will not be sufficient for receiving the doctorate. The granting of the Ph.D. is based primarily upon the student's knowledge of a specialized field of study and upon the production of an acceptable dissertation embodying the results of original research.

Requirements. The formal requirements for the Ph.D. degree are as follows: (1) major and related courses, (2) foreign language, (3) a supervisory committee for program of study, (4) residence, (5) preliminary examination, (6) dissertation, and (7) final examination. In order to be considered for candidacy for the Ph.D. degree, the student must have passing grades in all courses and a grade of G or better on at least 9 units.

Major and Related Courses. The student's program of study demands substantial concentration on courses in the department. However, a minimum of 6 units in a related field approved by the department must be included.

Foreign Language. Ph.D. candidates in forestry and environmental studies are ordinarily expected to have a reading knowledge of one foreign language. However, on recommendation of the student's supervisory committee, knowledge of a second language may be required. In exceptional cases, the language requirement may be waived completely.

Supervisory Committee. As early in a student's course of study as is practicable, and not later than two months before the preliminary examination, the director of

graduate studies will nominate for the approval of the dean a supervising committee consisting of five members, with one member designated as chairman. This committee will include at least three graduate faculty members from the department and at least one from outside the department. This committee, with all members participating, will determine the program of study and administer the preliminary and final examinations. Successful completion of the final examination requires four affirmative votes. The final examination may be administered by four members if the representative of the related field is present.

Residence. The minimum registration requirement is 60 units of graduate credit, of which not more than 15 units may be accepted by transfer. The minimum registration per semester is 12 units. The minimum full-time residence requirement is one academic year (two consecutive semesters) at Duke. All Ph.D. candidates must register for a full course load until they have completed the required 60 units of graduate credit. Those entering with undergraduate deficiencies may be required to take undergraduate courses for which they will not receive degree credit. The student's supervisory committee will determine what requirements above the minimum, if any, the student must meet.

More complete information and requirements for the preliminary examination, the dissertation, and the final examination are outlined in the bulletin of the Graduate School.

Nondegree, Special Status

Persons interested in pursuing graduate studies in natural resources not leading to a professional or a graduate degree may apply for nondegree, special status. Such students may take from 3 to 12 units of course work each semester; they are registered with the University as a student with appropriate privileges; they receive transcripts of work completed for each semester in residence; but none of their courses will count toward a degree to be received from Duke University. Students wishing to study for only one or two semesters or to do postdoctoral work should apply for nondegree, special status. Additional requirements are contained in a later section on admissions.

Programs of Study and Research

In the School of Forestry and Environmental Studies, maximum attention is devoted to the individual student. Emphasis is placed on maintaining the highest standards of scholarship and on relevance to contemporary needs in natural resources study and research.

The educational experience at Duke is enriched by a philosophy of interdisciplinary study that takes to full advantage the breadth of professional offerings in other schools on campus. In addition, the availability of courses at the nearby campuses of North Carolina State University and the University of North Carolina makes the Duke program uniquely strong in intellectual content. Within easy commuting distances formed by the triangle of universities is found the Research Triangle Park where major public and industry-supported research programs provide excellent opportunity for work-study internships and exposure to current topics in research.

The school emphasizes three broad conceptual areas in its instruction and research: applied resource science, resource economics and policy, and quantitative methods. Regular courses, intensive courses, seminars, and special studies are offered in each of the three areas. Preparation for professional employment requires a higher degree of specialization than is characterized by this framework, however. Hence, four programs of study have been designed by the faculty to assure competence in some aspect of natural resources while offering adequate breadth of educational experience. One of these programs, Forest Resource Management, is offered under the Master of Forestry degree; the remaining three, Resource Ecology, Water and Air Resources, and Resource Economics and Policy, are offered under the Master of Environmental Management or Master of Forestry degree; degree choice depends upon the student's career interests. Each program can be used as a foundation for obtaining the A.M., M.S., and Ph.D. degrees.

Qualified students who have interests outside of the structured programs are permitted to design individual programs of study. Pursuit of an individual program requires preparation of a comprehensive statement of objectives and specification of each of the program components: major courses, minor courses, seminars, electives, and a master's project. All individual programs of study are subject to approval by the faculty council.

Program Requirements

Each of the school's programs of study and research have similar requirements within the broad categories discussed briefly below. More specific information about requirements for any one of the programs can be obtained from the director of admissions.

Prerequisites. Students admitted to the school are expected to have had at least one introductory course in calculus, statistics, economics, and computer programming. They are also expected to have had some previous training in the natural sciences or the social sciences related to their area of interest in natural resources. For students who select either the Resource Ecology or the Forest Resource Management program, this previous training must include an introductory course in ecology.

Students who do not satisfy all of these prerequisites may be admitted to the school but will be expected to make up these deficiencies during their first year of residence. Elective credits may be used to satisfy up to two deficiencies.

Credit Requirements. Each program requires the completion of 60 units of credit. These units are distributed among a set of required courses constituting the major, elective courses, a set of courses forming the minor, a master's project, and seminars relevant to the program's objectives.

Major courses. Each program requires from six to eight courses (13 to 29 units) in the major area of study. These courses are specified or, in some cases, elective within the limits of the program emphasis.

Elective Courses. Elective courses are available to give the student flexibility in developing his or her course of study. These credits are used to add depth to the major area of study or to develop a second area of expertise. Students who select the Resource Economics and Policy program and who have not had previous training in a natural resource area must use at least three of their elective courses to meet this requirement.

Quantitative and Analytical Minor. All programs require a minor of at least three courses (9 to 12 units) in quantitative and analytical methods related to natural resource analysis, modeling, and management.

Master's Project. A master's project constituting 4 to 8 units of credit is required. These projects take the form of individual or small group research efforts related to some area of natural resource management.

Seminars. All students are required to participate in seminars in their program area for 1 to 3 units of credit. During the spring semester of their second year in residence, students present the results of their master's project.

Forest Resource Management

The Forest Resource Management program integrates the biological and physical components of forest productivity with methods of modern business management. The program builds knowledge in basic forest ecology and integrates this knowledge with foundations in planning and administration for the production of forest resources. This distinctive approach is brought about by close coordination of resource inventory course work; resource oriented courses such as soils, silviculture, timber production, forest protection, tree physiology and genetics; management oriented courses such as operations research, modeling, and ecosystem analysis as applied to research and development; and courses in resource economics and policy.

The program emphasizes the use of computer based, quantitative techniques to facilitate decisions on the selection of management options to achieve objectives. Various methods of analysis are applied to all forest resources in order to optimize production within the constraints imposed by biological, physical, and economic conditions.

The central focus of the Forest Resource Management program is problem solving in complex ecologic and management systems. Within the program, students have the flexibility to gain depth in an area of specialization. Consequently, students may acquire skills that qualify them for a variety of positions in forest products industries,

government agencies, nonprofit organizations, and other groups concerned with the management, utilization, and protection of forests. The program also provides an excellent foundation for the Ph.D. and a career in research. Students who complete this program, offered under the Master of Forestry degree, and also complete a Master of Business Administration degree in the Fuqua School of Business have particularly strong credentials for employment in private industry.

Resource Ecology

The Resource Ecology program is offered under either the Master of Environmental Management degree or the Master of Forestry degree if the primary focus is forest ecology. It is concerned with the application of ecological theory to the manipulation and management of both terrestrial and aquatic ecosystems. An integrated management scheme is advocated; that is, one which takes into account economic constraints, environmental ethics, and political reality.

The framework for the development of management guidelines is provided by these general ecological mandates: the recognition of a hierarchical order of study (organism, population, community, and ecosystem); the prevention of irreversible losses of ecosystem processes; the recognition and understanding of connections among various ecosystems; and the maintenance of ecosystem integrity for future generations.

The applied thrust of the program allows the student to anticipate as well as to answer questions about environmental and ecological management problems. Problem solving is based on the best possible scientific description of ecological processes and relates to appropriate data bases. Applied ecology recognizes the needs of the environmental management user community and provides an organizing framework and an information system to help minimize resource use conflicts.

Mathematical and conceptual models are invaluable in clarifying ecosystem organization. They are essential to describe basic biophysical processes, to test hypotheses, and to predict the response of ecosystems to disturbance. Consequently, a strong background in quantitative methods is required of students in this program, as it is for other programs offered by the school.

The objective of the Resource Ecology program is to train professionals for management or research positions with state or federal natural resource agencies, regional planning bodies, resource development companies, and consulting firms. Graduates of the program have practical experience with the analysis of actual ecological problems such as flooding, disturbance of wetlands, the effects of toxic substances and fertilizers on ecosystems, integrated pest management, and mining reclamation.

Water and Air Resources

The program in Water and Air Resources is concerned with the management of these renewable natural resources and their interaction with land related resources. Particular emphasis is placed on the effects of land resource management on water quality and quantity and on air quality.

Majors in the program can select one of two areas of concentration: either water resources or a combination of water and air resources.

Course work and other training in the program cover basic hydrologic and atmospheric processes, methods of quantitative analysis, and methods of management and decision making. The basic processes emphasized are those concerned with watershed hydrology; stream and lake water quality; general meteorology and climatology; and the origins, transport, and removal of atmospheric pollutants. Quantitative analysis techniques include statistical methods, probabilistic and deterministic models, and optimization and simulation methods. These courses are integrated with

others in water resource management, air resource management, and economic analysis.

Graduates of the program earn the Master of Environmental Management degree or the Master of Forestry degree with a specialization in water and air resources. They have the skills to become analysts or consultants for private industry and public agencies concerned with the management and protection of water and air resources. These employers include regional planning agencies, public utilities, fuel and ore extraction corporations, consulting firms, and hydrologic or environmental research centers.

Resource Economics and Policy

Society long has had laws and institutions aimed at regulating the use of natural resources such as forests, range lands, wildlife, water, and minerals. During the past few decades, new institutions have been developed to deal with problems of water and air pollution, toxic substances, and related areas of environmental degradation. These institutions demand a professional who has the necessary expertise to staff both public and private decision-making bodies.

Offered under either the Master of Environmental Management or the Master of Forestry degree, the Resource Economics and Policy program is designed to train such decision makers. The program emphasizes the basic methods needed by the professional for analyzing existing policy and for testing the possible outcome of new environmental and resource policy being considered by public and private agencies. The program is highly analytical and is oriented toward the analysis of contemporary problems.
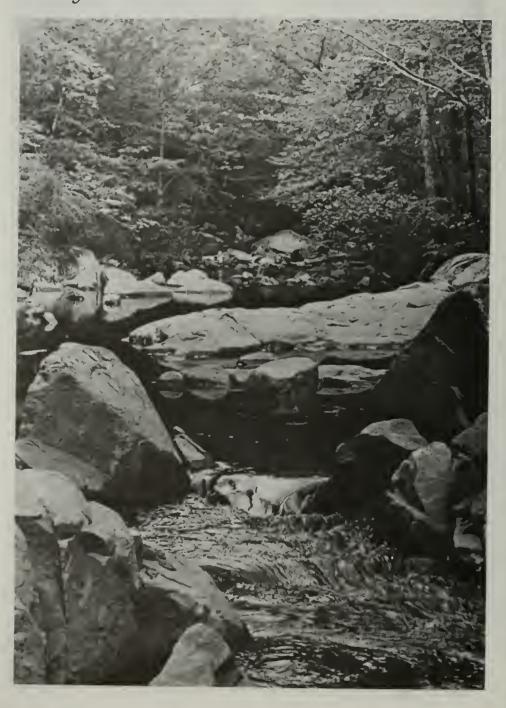
Decision making in natural resource and environmental policy requires mastery of three broad areas of knowledge: the basic sciences pertaining to a natural resource or an environmental phenomenon; the relevant disciplines in the social sciences; and the quantitative methods required for using knowledge from the physical, biological, and social sciences to arrive at a decision.

Courses relevant to renewable and nonrenewable natural resources may be part of the student's educational background or may be planned as part of the master's degree. For the natural resource decision maker, the most important social sciences are resource and environmental economics, political science, and legal analysis. Economics includes production economics, the economics of public goods and externalities, public finance, and the intertemporal allocation of natural resources. Political science includes the behavior of administrative agencies, regulatory agencies, and legislative bodies. Legal analysis emphasizes the allocation of resources as reflected in property rights and environmental risks as reflected in torts. Quantitative methods, an essential component of this program, includes statistical inference, methods of optimization, and decision theory.

Students in the program have the opportunity to assist in ongoing research projects in the school's Center for Resource and Environmental Policy Research and the nearby Southeastern Center for Forest Economics Research. Such training provides a comprehensive background for a wide range of resource analysis and management careers.

Center for Resource and Environmental Policy Research

Acting Director

Jack P. Royer, *Assistant Professor*

Faculty

Ralph J. Alig, *Adjunct Assistant Professor*
George F. Dutrow, *Professor*
Robert G. Healy, *Adjunct Associate Professor*
Milton T. Heath, *Adjunct Professor*
William F. Hyde, *Associate Professor*
Carlos M. Marin, *Assistant Professor*
Kenneth H. Reckhow, *Associate Professor*
Harold K. Steen, *Adjunct Professor*
James G. Yoho, *Professor of the Practice of Forest Investment*

The Center. The Center for Resource and Environmental Policy Research is committed to objective and timely analyses of critical natural resource and environmental issues, both national and international.

During the past few years, a substantial and comprehensive body of legislation has been enacted to address resource and environmental problems, much of it strongly influenced by information provided by special interest groups. Often, this legislation has been drafted and passed in a quasi-crisis atmosphere with a consequent absence of mature deliberation. The center was developed in response to recognition of the many conflicts developing over competitive use of natural resources and consequent legislative regulation.

Because contemporary resource-environmental problems are deeply embedded in the social, economic, and political fabric of the country, they are in need of careful and deliberate study. It is in the national interest that such issues be examined in a setting conducive to independent thought with appropriate regard for timeliness of results and conclusions. The Center for Resource and Environmental Policy Research at Duke University is designed specifically to provide the proper setting for such an approach.

Among the current research topics are:

- Land Use Planning and Rural Development
- Policy for Resource-based Industry Development
- Educational Research and Policy Issues
- Water Resources Policy
- Resource Economics and Policy
- Forest Planning and Protection Policy
- Environmental Risk Analysis
- International Resource and Environmental Policies

The Center Organization. The center is by design and intent a flexible, multidisciplinary unit. Headed by a director and staffed by an interdisciplinary faculty, the center offers opportunities for involvement to executives, administrators, political representatives, mid-career professionals, academicians, and graduate students. A major aim is to bring together special groups of scholars and professionals to focus their attention on contemporary resource and environmental research problems.

The center is viewed as an all-campus unit at Duke University, drawing primary support from the School of Forestry and Environmental Studies while maintaining strong associations with the Schools of Law, Business, and Engineering, and the Institute of Policy Sciences and Public Affairs.

Beyond the Duke campus, the center maintains close ties with officials from government and industry and the faculty and students of other universities, particularly the University of North Carolina and North Carolina State University.

Several members of the center's faculty are allied with the Southeastern Center for Forest Economics Research. This consortium, headquartered at the Research Triangle Park, is sponsored by the United States Forest Service and several regional universities.

Graduate Study. The center provides opportunity for graduate study at the master's and doctorate level in two major areas, policy and economics, and provides minor emphasis in these same topics to students from other subject areas. Degrees are offered through the School of Forestry and Environmental Studies; in addition, concurrent degrees may be developed with the Institute of Policy Sciences and Public Affairs and with the Fuqua School of Business. Students interested in the degree program should contact the center director for a current course list and for formal admission.

For the student interested in a graduate research program at the M.S. or Ph.D. level, individually designed programs of study are directed by the center faculty in accordance with Graduate School policy.

The center offers graduate assistantships to qualified students in resource and environmental policy research. Support is available to students pursuing M.S., A.M., or Ph.D. degrees through the Graduate School at Duke University and M.F. or M.E.M. degrees in the School of Forestry and Environmental Studies.

Director

William K. Condrell, *Adjunct Professor*

Associate Director

James G. Yoho, *Professor of the Practice of Forest Investment*

Faculty Associates

George F. Dutrow, *Professor*
William F. Hyde, *Associate Professor*
Benjamin A. Jayne, *Professor*
George H. Mason, *Visiting Instructor*
Clark Row, *Visiting Instructor*
Jack P. Royer, *Assistant Professor*
William R. Sizemore, *Adjunct Professor*
Harold K. Steen, *Adjunct Professor*

Objectives of the Center. The Center for Forestry Investment is devoted to a broad program of education and research that is concerned with all aspects of private forest investment under a free market system and private ownership of property. While its geographic focus is essentially national, the center has a strong orientation to the main commercial forest regions of North America.

The center provides a focus on a critically important area dealing with future timber availability in the United States. Heretofore, there has been no central place to consider the effects of national policies on forest investment activity. Policies dealing with taxes, appraisal, insurance, and financial and institutional requirements have been developed largely without respect to the central question of how to satisfy both domestic and export markets for forest products.

Forest investments warrant particular attention because they are unique in many respects. They are capital intensive, long term, and offer only modest yields. Given these characteristics and current economic conditions, it is a challenge to facilitate the private investments required to supply the nation with low-cost timber products while leaving a surplus for export to world markets at competitive prices. At the same time, this must be accomplished without detriment to future forest resource productivity and environmental quality.

Organization and Administration. Headed by a director and an associate director, the center is a flexible, multidisciplinary unit based in the School of Forestry and Environmental Studies. It maintains close ties to other professional schools and departments within Duke University. It also draws upon the school's Center for Resource and Environmental Policy Research; the Forest Service's Southeastern Center for Forest Economics Research; the forest products industry; trade associations; and the

insurance, pension fund, and financial communities for instructional assistance, advice, and consultation.

Activities of the center include conferences, symposia, and workshops dealing with the major substantive areas affecting forestry investment. Faculty in the center teach relevant courses in the school's Forest Resource Management program.

Comprehensive and scholarly research in the broad area of forestry investment is central to the mission of the center. Among the research topics are

- Investment opportunities, methods, and returns
- Barriers to investment growth in private forestry
- Appraisal, valuation, and accounting systems
- Insurance and risk management
- Issues related to property, income, and estate taxation
- Vehicles for making private investments in forestry

Publication is also an important function of the center. Conference proceedings are published as are reports on research findings. Such findings may be published as bulletins or as articles in appropriate scholarly journals.

Opportunities for Graduate Study. Specifically tailored programs of study and research may be designed to meet the goals of individual students and supervised by faculty members associated with the center. Programs leading to the Master of Forestry or Master of Environmental Management degree are administered by the School of Forestry and Environmental Studies.

For students interested in graduate research at the M.S. or Ph.D. level, individually designed programs of study are directed by faculty associated with the center in accordance with Graduate School policy.

Financial support for study and research may be available for the individual student if his or her interests contribute to the center's research objectives.

Forest History Society

Founded in 1946, the Forest History Society is a nonprofit, nonadvocacy organization committed to balanced and objective investigations of human interaction with the forest environment through time. Although its major focus is North America, the society is involved with a network of forest historians worldwide. In 1984, it became affiliated with Duke University and moved its headquarters to Durham.

The society emphasizes the utility of history to decision making in both the public and private sectors. The society believes that most currently held opinions are strongly influenced by perceptions of the past and that a clear understanding of what really happened, as today's issues evolved, is a vital component in the process of making prudent choices.

Five major emphases enable the society to achieve its goals: *Journal of Forest History*, research and publication, archival collecting, library and reference, and service and professional outreach.

The *Journal of Forest History* is published quarterly. Its refereed articles, book reviews, bibliographic listings, and news enable investigators to keep current with the field. Research and publications, supported largely by grants, focus on topics that are important today and are also significant historically. Among the current topics are the history of forest resource technology, forest economics, sustained-yield forestry, Indian lands forestry, wood as an energy source, forest taxation, labor relations in the forest industries, and industrial forestry research.

The collection of archival materials has been a major effort since the society was founded. Included in the archives are the records of the American Forest Institute, National Forest Products Association, and the Society of American Foresters. The society's library and reference staff provide convenient access to the extensive literature of the field. Students and faculty of the university are welcome to use these valuable resources. The service and outreach emphasis enables society staff to be active participants in their professions. Included are teaching and advising assignments at the School of Forestry and Environmental Studies.

Inquiries regarding the facilities and services offered by the society may be addressed to Harold K. Steen, Executive Director, Forest History Society, 701 Vickers Avenue, Durham, NC 27701.

Integrated Toxicology Program

The School of Forestry and Environmental Studies houses the ecotoxicology track of Duke University's graduate program in toxicology. The Integrated Toxicology Pro-

gram operates under a specific charter to develop holistic and innovative approaches to toxicology training and to provide three training tracks: (1) general toxicology, with broad training in the principles and concepts of toxicology; (2) specialized toxicology, emphasizing such areas as pulmonary toxicology or biochemical toxicology; and (3) ecotoxicology.

The study of ecotoxicology focuses on the principles and concepts of both toxicology and ecology as they relate to the release, transport, exposure, accumulation, and effects of toxics on humans and ecosystems. The curriculum is designed to teach the student the basic principles of biochemistry, physiology, toxicology, pathology, and ecology along with specific skills in ecosystem analysis, environmental health, epidemiology, statistics, and risk analysis so that he or she can design, execute, and interpret experiments in ecotoxicology.

Completion of this training program at the Ph.D. level provides career opportunities in academia, industry, and research laboratories. Master's candidates are trained for careers in industry, consulting firms, and government agencies concerned with the management of hazardous substances.

An ecotoxicology student is affiliated as a postdoctoral fellow or graduate student (Ph.D. or M.E.M.) in the School of Forestry and Environmental Studies or the Duke Marine Laboratory. All students are required to complete the core sequence of the Integrated Toxicology Program and the ecotoxicology track requirements in addition to specific degree requirements.

Students seeking admission to the program as a Ph.D. candidate make initial application to the Graduate School for admission to the Department of Forestry and Environmental Studies. Candidates for the Master of Environmental Management degree apply directly to the School of Forestry and Environmental Studies. Fellowships are available to outstanding students. Further information on the program can be found in the bulletin of the Integrated Toxicology Program.

Integrated Case Studies in Natural Resource Analysis

The case study approach to graduate education affords the student an opportunity to develop analytical and management skills through a close look at problems in resource management and policy. Case studies are used in class instruction in both traditional and intensive courses in several of the school's study areas.

In addition to utilizing completed case studies as course materials, students also have the opportunity to participate in the research and preparation of new case studies. The process of case preparation brings one in contact with professionals, businessmen, and others and offers a bridge between the academic curriculum and practical experience. This experience and the contacts made in the process of case research are valuable assets in securing employment.

The case studies are termed "integrated" case studies in natural resource analysis because they result from the cooperative efforts of a team of investigators comprising resource-ecologists, -economists, and -planners, as well as political scientists, sociologists, and others. The team approach is used in recognition of the fact that the successful analysis and resolution of the nation's complex resource and environmental problems requires a holistic perspective. Optimally, this results in an exploration of the full ramifications of utilizing natural resource systems.

One objective is to disseminate results of the integrated case studies beyond the walls of the School of Forestry and Environmental Studies. User groups have ranged from federal agencies to local and regional planners. Reflecting these diverse audiences, case study formats have varied. For example, projects have resulted in color and sound 16mm films, simulation games and workshop/conferences, as well as written reports. Typical issues addressed by past case studies include highway siting,

emergency hazardous waste disposal, back country management, forest management, and the development of wetlands.

Financial assistance, in the form of graduate fellowships, is available to qualified students interested in case study analysis. Up to 8 units of academic credit may be earned for case study work. Arrangements are made in consultation with the student's faculty adviser and the case studies director.

Intensive Courses

Intended for both practicing professionals and advanced full-time students who are pursuing careers in resource management, policy, and environmental science, the intensive courses offer an alternative to traditional full-semester courses. The sessions are designed to allow regular students to blend theory with practical experience as well as to allow experienced professionals to update theory and methodology. Recognized subject matter specialists provide instructional resources not normally available to the University community. The result is an enriched educational experience through the exchange of ideas and information by participants of diverse backgrounds.

The intensive courses are organized into week-long modules and classes are held three or more hours a day during the week. A course consists of one, two, or three modules, each a discrete unit of study which may be taken alone for credit. In multimodule courses, however, the first week may be a prerequisite to other weeks in the series.

School of Forestry and Environmental Studies students (M.F. and M.E.M. degree candidates) earn 1 to 3 units of credit for each intensive course. Registration is limited; students in their second year of study are given priority. Students may not register for more than two intensive courses in a semester without special permission from the faculty council.

Courses in the intensive course series are listed in a special section in the chapter "Courses of Instruction" in this bulletin. They also are described as part of the Senior Professional Program. A brochure containing complete information on the intensive courses to be offered during a semester may be obtained from the school office.

Laird, Norton Distinguished Visitor Series

Through the generosity of the Laird, Norton Foundation of Seattle, Washington, a Distinguished Visitor Series has been established to bring outstanding guests to the School of Forestry and Environmental Studies each Friday during the spring semester. The major focus of their day on campus is a noontime seminar on current land management concepts, practices, and policy issues. Topics and speakers are selected in accordance with interests of faculty and students to reflect the international natural resource scene, as well as the major timber growing regions of the United States. Speakers are drawn from the senior administrative ranks of public agencies, industries, nonprofit organizations, and the consulting field. Each presentation is followed by an informal luncheon with a smaller group of students and faculty, which permits continued discussion. In addition, students and faculty can arrange to meet privately or in small groups with the guest during the morning. The Distinguished Visitor Series can be taken for 1 unit of seminar credit, if a student desires.

In addition to the Distinguished Visitor Series, the Laird, Norton Foundation grant helps to support other courses and activities which meet the objective of the exchange of ideas between practicing natural resource professionals and university students and faculty. These activities include a forest management seminar series, a forest utilization field trip to industry facilities in the South, and a western field trip to be inaugurated in 1987.

Internships

An internship with a public agency, forest products industry, environmental consulting firm, or conservation organization is a valuable part of graduate professional education. The School of Forestry and Environmental Studies Office of Placement and Internship works with natural resource professionals to develop intern opportunities for all interested Master of Forestry and Master of Environmental Management degree candidates.

In 1985 and 1986, a pilot project with the North Carolina Department of Natural Resources and Community Development provided twelve students with full-time summer employment and part-time employment with the same agency during the following academic year. Other employers have shown interest in the project, and support continues to be manifest through the development of new internships. Because employers often specify professional experience as a requisite for hiring, the student's options for permanent positions are expected to expand in proportion to the number of internships available.

The student is required to spend at least two full semesters in residence at Duke prior to accepting an internship and must return to the University for at least one full semester following completion. Academic credit can be earned for an internship; however, in order to receive credit, a plan of study must be prepared in advance and approved by the student's faculty adviser and the dean. The internship must contribute substantially to the educational objectives of the student. With approval, students may use a part or all of the intern experience to fulfill the master's project requirement. Further information may be obtained from the school office.

International Studies

The School of Forestry and Environmental Studies has a history of contribution to international education and research. Graduates of the school, some of them foreign nationals, hold significant positions in many countries—in multinational corporations, United States government agencies, or resource and conservation organizations that have global responsibilities. Members of the faculty have served overseas in programs of teaching and research, in both the developed and developing parts of the world.

The contemporary need for greater attention to international studies has led the school to develop professional associations and curriculum options for students who wish to combine international interests with study of natural resources and the environment. Duke University is a member of the South-East Consortium for International Development, the South Atlantic States Association for Asian and African Studies, and the Organization for Tropical Studies. On campus, an active Center for International Studies provides a rich array of educational and research opportunities with global emphasis. The potential exists for student participation in international projects through competition for grants and fellowships. In addition, students in the school may elect area studies or languages to further their understanding of global issues and cultures.

The school welcomes foreign students and considers an international student body of value to the learning environment. Through both formal and informal interaction, students from various cultures exchange information and opinions on resource and environmental problems and their alternative solutions. Qualified foreign students in Trinity College and in graduate and professional schools of the University are admitted to courses in the school, subject to the approval of the student's dean and the dean of the School of Forestry and Environmental Studies.

Cooperative Colleges

The Cooperative College Program is designed to coordinate the education of students in selected undergraduate schools with graduate programs in the broad area

of resources and environment offered at Duke. Students are accepted for either of two degrees, the Master of Forestry (M.F.) or Master of Environmental Management (M.E.M.). Although the program is designed to accommodate a wide range of undergraduate backgrounds, experience of several years indicates that it is best suited to majors in one of the natural or social sciences, pre-engineering, business, natural resources, or environmental science.

The program accepts students after three years of undergraduate study or upon completion of the baccalaureate. With appropriate guidance, highly qualified students can reach a satisfactory level of preparation for graduate work at Duke in three years of coordinated undergraduate study. The baccalaureate degree is awarded by the undergraduate school after the student has earned enough units at Duke to satisfy the requirements of the undergraduate institution. Minimum time required to complete the bachelor's degree is two full-time semesters at Duke. After four semesters at Duke, in which a minimum of 60 units of credit is earned, students may qualify for one of the professional master's degrees.

A student interested in entering the Cooperative College Program should apply to one of the participating schools. Each can provide information on courses of study and bachelor's degree requirements. Students applying for admission to Duke after the third year of study should do so early in the first semester of the third year. Students applying for admission after completion of the baccalaureate should return completed application materials by 15 February. Applicants from the participating schools are considered regular applicants for admission and are judged by the same criteria; therefore, students should submit application forms, transcripts, letters of recommendation, and results of the Graduate Record Examination.

Senior Professional Program

Keeping up with new knowledge presents a challenge to all professionals. For the natural resource based industries and agencies, the problems of technical change are compounded by rapidly changing social, political, and economic values. The forest resource, for example, must be managed to produce a reasonable return on investments as well as to provide a reliable source of future raw materials. The forester of today must be well-versed in the techniques of forest management and those of resource analysis to ensure financial solvency in times of increasing economic stress. An understanding of the management sciences and the concepts of operations research is also vital. Few natural resource professionals have this background, however, and few are able to combine formal, continuous educational programs with the day-to-day pressures of a career.

The School of Forestry and Environmental Studies recognizes the need for contemporary educational opportunities for professionals in the field and for efficient use of the individual's time. The Senior Professional Program is intended to provide working professionals with an opportunity to come to Duke University either to update managerial skills or to earn a professional master's degree with a minimum period of residence. The program offers symposia, managerial seminars, intensive courses, and regular University courses for qualified professionals.

Fellowships-in-residence also are available. Elements of the program may be taken for intellectual gain, for certified continuing education (CEU) or Continuing Forestry Education (CFE) credit, or for graduate credit. Formal degree work may be carried out through a combination of approaches.

The Senior Professional Program allows the participant to tailor an educational experience to individual needs. A brief description of opportunities follows. Inquiries for further information may be addressed to the Office of the Dean.

Symposia and Managerial Seminars

The School of Forestry and Environmental Studies annually sponsors one- or two-day symposia and seminars. Recent sessions have dealt with alternative uses of coastal wetland ecosystems, United States and Canadian interdependence on natural resources, and data and information needs for nonindustrial private forests. Managerial seminars have covered such topics as legal problems in woodlands operations, financial accounting, and principles of taxation applied to the forest industries. Presentations at these meetings are made primarily by outside experts, with Duke faculty serving as moderators and panelists. Although participants in the symposia and seminars do not earn academic credit, they do have an excellent opportunity to meet other professionals, exchange ideas, and increase their knowledge in the area of discussion.

Intensive Courses

The cornerstone of the Senior Professional Program, the intensive courses cover a wide variety of topics focusing on the management and analysis of forest, land, and water resources. Subject matter is changed periodically in response to the needs of working professionals. Instructors are experts who have an established reputation in their respective fields. As a result, participants are exposed to up-to-date, state of the art information that is available from few other sources.

The intensive courses are structured as week-long modules in which classes meet twice a day for a minimum of fifteen lecture hours. The classes often include workshops and independent or group projects in addition to formal lectures in a classroom setting. Ample time is allowed for informal discussion with the instructor and other class members.

All professionals receive a certificate of recognition upon completion of an intensive course. Those who wish may receive certified continuing education credit (CEU) by so specifying upon registration. The courses also qualify for Continuing Forestry Education (CFE) credit administered by the Society of American Foresters. Participants who are admitted to the School of Forestry and Environmental Studies as candidates for the Master of Forestry or Master of Environmental Management degree may take certain intensive courses as part of degree requirements. These students may earn 1 to 3 units of credit for an intensive course.

Intensive courses are listed in a special section in the chapter "Courses of Instruction" in this bulletin. A brochure describing the Intensive Course Program, courses offered during a particular semester, registration procedures, and fees is available upon request.
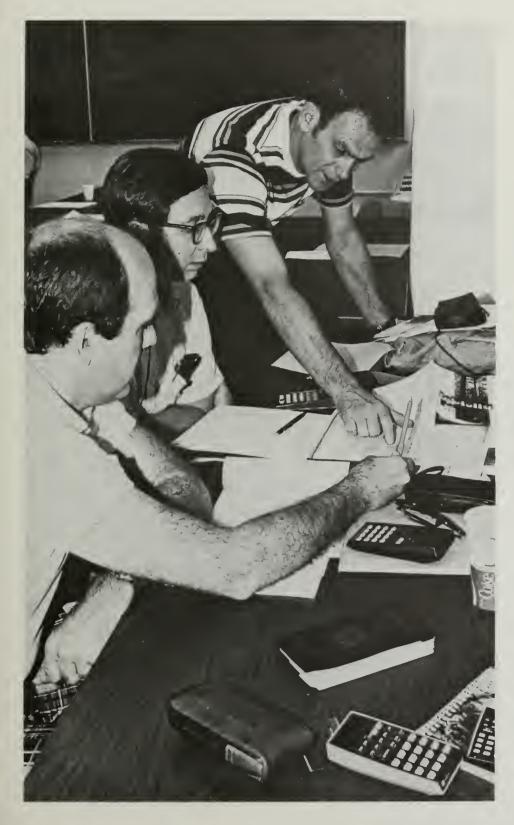
Fellowships in Residence

Fellowships in residence are available through the Senior Professional Program to provide study periods of varying length on the Duke campus. Fellows may take formal courses or work on independent study projects or research under the direction of a faculty member. Graduate credit may be awarded where appropriate to fellows who are admitted to the School of Forestry and Environmental Studies as degree candidates. A limited amount of financial assistance is available.

Master's Degrees for Professionals

Qualified professionals may be admitted to the School of Forestry and Environmental Studies as part-time students. By taking a three-month leave of absence from their jobs, these professional degree candidates spend a full semester at Duke enrolled in regular, graduate level courses. Up to 15 units of academic credit are taken during this time. The remaining 15 or more units of credit needed for a Master of Forestry or Master of Environmental Management degree may be earned in absentia or on campus as career responsibilities permit. Part-time degree candidates have up to five years in which to complete all requirements.

Specific degree requirements for students in the Senior Professional Program, including required courses and the number of academic units necessary to complete the degree, are established by the faculty council upon evaluation of the individual's previous education, working experience, and career goals. A minimum of one semester in residence and 30 units of credit are required. A master's project, which may be completed in absentia, representing 4 to 8 units of credit also is required.

Applicants for degrees through the Senior Professional Program follow the same application procedures as regular students in the school. Applications must be submitted by February for the fall term and by October for the spring term. Normally, degree candidates in the Senior Professional Program take the required semester in residence during the term following admission.

Career Planning and Placement

Placement

The School of Forestry and Environmental Studies operates its own career planning and placement services for all incoming students, graduate and professional students, and alumni of the school. Assistance is given to students in finding summer employment and internships following completion of the first year of study, permanent employment upon graduation, and mid-career changes of employment.

Career Planning Seminars. Individual counseling and group workshops are provided by a professional staff member to assist students in the development of job search strategies and skills, resume preparation, and interviewing techniques. Presentations by alumni of the school enable students to discuss employment options with practicing natural resource professionals.

Job Search Assistance. The Office of Placement and Internship maintains a current listing of employment opportunities from private industry; local, state, and federal governments; universities; and nonprofit organizations. Career planning and placement resource materials are housed in the office. Both current students and graduates are encouraged to use the alumni network established to offer placement assistance.

A resume book is published annually by the school and distributed nationally to potential employers. Students are encouraged to prepare and submit resumes, with the assistance of the staff, for publication. Employer response to the resume book has been favorable, and many students have received initial contacts and invitations to interviews as a result.

On-campus Interviews. Each year the School of Forestry and Environmental Studies placement office, in conjunction with the Duke University Office of Placement Services, 214 Flowers Building, invites representatives from a number of firms and government agencies from throughout the country to visit the school to interview students for internships and permanent positions. Second-year degree candidates are offered an opportunity to assemble a complete dossier of academic records and recommendations to supplement applications for positions and to have a permanent file for future reference. All dossiers are kept in the University's Office of Placement Services to insure confidentiality. Students are strongly urged to begin formulating their job-hunting strategies and implementing the job search at least six months prior to graduation.

Employment Offers. The success experienced by degree candidates in securing employment serves as a strong testimony to the value of graduate/professional study at Duke. Students are advised to gear their education to a specialized area in order

to increase their marketability. Toward this goal, every effort is made to place each student in a paid internship appropriate to his or her field of study and geographic preference. Summer placements with local organizations are often continued as part-time positions during the student's second year of study, adding to the base of professional experience.

Beginning salaries vary, depending upon the educational specialization, capabilities, and prior experience of the candidate as well as the type of organization and geographical region in which he or she is employed. For recent graduating classes, beginning salaries have ranged from $16,000 to $33,000 annually with candidates having some prior experience and/or advanced quantitative skills commanding the higher figures.

Despite the economic climate of the early 1980s, graduates of the school have continued to find challenging, satisfying employment within their areas of interest. Environmental consulting firms and the forest products industry have attracted a large percentage of recent graduates. A somewhat smaller number have accepted employment with federal, state, and local governmental agencies and conservation organizations.

The market for natural resource managers is expanding. In both the private sector, where environmental divisions are being established within traditional corporations, and in the public sector, where policy-making bodies increasingly face environmental concerns, School of Forestry and Environmental Studies graduates are hired in research, planning, administrative, and consulting capacities. To a smaller degree, international organizations utilize natural resource managers; students interested in

international employment usually benefit from experience such as that gained through the Peace Corps.

The following is a list of selected organizations with which graduates of the past several years are affiliated.

The Aerospace Corporation
Agriland Associates
Alabama Forestry Commission
American Forest Institute
Appleton Papers, Inc.
Arkansas Nature Conservancy
City of Baltimore, Maryland
Bartlett Tree Expert Company
Battelle Columbus Laboratories
Boise Cascade Corporation
Buckeye Cellulose Corporation
Champion International Corporation
Chesapeake and Potomac Telephone Company
Chesapeake Corporation of Virginia
Clemson University, Department of Recreation
     and Park Administration
Connecticut Department of Environmental
     Protection
Container Corporation of America
Government of Costa Rica
Crown Zellerbach Corporation
Duke University, School of Forestry and
     Environmental Studies
Duke University, Center for International Studies
Environmental Research and Technology, Inc.
Florida Division of Forestry
GCA/Technology, Inc.
Georgia-Pacific Corporation
Green Diamond Forestry Service
INTASA, Inc.
International Paper Company
ITT Rayonier, Inc.
Ketron, Inc.
King County, Washington
Louisiana-Pacific Corporation
Maryland Department of Agriculture
Maryland Land Trust
The Mead Corporation
Montana Division of Forestry
National Bank of North America
National Forest Products Association

National Park Service
Government of Nepal
New Hampshire Office of State Planning
North Carolina Department of Natural Resources
     and Community Development
North Carolina State University, Agricultural
     Extension Service
Oak Ridge National Laboratories
Ohio Agricultural Research and Development
     Center
Oklahoma Scenic River Commission
Oswego County, New York, Department of
     Planning
Pacific Environmental Services
Peace Corps
Quinault Indian Nation, Department of Natural
     Resources
Radian Corporation
Research Triangle Institute
Resources for the Future
Scott Paper Company
South Carolina Commission of Forestry
South Carolina Nature Conservancy
South Dakota Division of Conservation
TRW, Environmental Engineering Division
Union Camp Corporation
United States Agency for International
     Development
United States Bureau of Land Management
United States Bureau of Reclamation
United States Department of Agriculture, Forest
     Service
United States Environmental Protection Agency
University of Florida, School of Forest Resources
     and Conservation
University of Maine, School of Forest Resources
WAPORA, Inc.
Westvaco Corporation
West Virginia Department of Agriculture
Weyerhaeuser Company
City of Wilson, North Carolina

Admissions

The student contemplating study at Duke in natural resources and the environment can enter either the School of Forestry and Environmental Studies or the Graduate School. Admissions procedures differ somewhat depending on the choice of degrees. The professional degrees, consisting of the Master of Forestry (M.F.) and Master of Environmental Management (M.E.M.), are administered by the School of Forestry and Environmental Studies. Students wishing to earn either of these professional degrees should apply directly to the school. Those preferring to earn a Master of Science (M.S.), Master of Arts (A.M.), or Doctor of Philosophy (Ph.D.) degree should apply to the Graduate School. Students contemplating study for the Ph.D., but who are undecided at present, may find it desirable to complete one of the professional master's degrees in the school (M.F. or M.E.M.) and apply to the Graduate School for admission to the Ph.D. program at a later date.

Admission to the School of Forestry and Environmental Studies

The School of Forestry and Environmental Studies welcomes applications from men and women of all backgrounds who seek an intellectually challenging education designed to prepare them for leadership in a wide variety of natural resource and environmental positions. The programs do not require previous study in forestry or environmental studies. However, they are designed primarily for students with a degree in one of the natural or social sciences (including chemistry, biology, physics, economics, earth sciences, environmental sciences, mathematics, and political science) or a preprofessional area such as forestry, engineering, or business.

Admission is open to men and women who hold a bachelor's degree from an accredited college or university or who have completed at least three years of study in an institution participating in the Cooperative College Program. Students who do not have a bachelor's degree and are not enrolled in one of the cooperative colleges may apply to the school for special eligibility. Special eligibility is granted in a limited number of cases to individuals who can meet the school's admission criteria and who have completed the equivalent of 90 semester hours of acceptable undergraduate credit. Those interested in consideration for special eligibility must receive approval from the director of admissions before submitting an application.

Admission as a special or nondegree student may also be granted under appropriate circumstances.

Prerequisites. Students admitted to the school are expected to have had at least one introductory course in calculus, statistics, economics, and computer programming. They are also expected to have had some previous training in the natural

sciences or the social sciences related to their area of interest in natural resources. For students who select either the Resource Ecology or the Forest Resource Management program, this previous training must include an introductory course in ecology.

Although students without the level of preparation described above may be accepted for admission, it is expected that deficiencies will be made up prior to entrance by means of formal course work, independent study, or other arrangements agreed upon by the applicant and the school. A limited number of deficiencies may be made up during the first year of residence. Up to two elective courses may be used for this purpose. Students will be notified upon admission of any apparent deficiencies.

Admission Criteria. Admission to the School of Forestry and Environmental Studies is highly selective. Academic performance as an undergraduate, scores on the Graduate Record Examination, and full-time work experience are the primary factors. Recommendations, the statement of educational goals, extracurricular activities, part-time and summer work experience, and other information requested on the application also provide a basis for selection.

The Admissions Committee considers each applicant as an individual. It attempts to evaluate each candidate for his or her academic potential, professional promise, and ability to benefit from and contribute to the goals of the school.

Application Procedures. Except in unusual circumstances, students are admitted only at the beginning of the fall term. Applications are accepted at any time; however, applications which include requests for financial aid must be submitted by 15 February preceding the fall in which admission is desired. Because the school processes applications from more qualified students than it can admit, early submission of applications is recommended.

Students who, because of unusual circumstances, wish to begin their studies in January should complete their application no later than 15 October prior to their matriculation. It should be noted that all financial awards are allocated to students beginning in the summer or fall, and no awards will be considered for January applicants.

Application for admission to the Master of Forestry and Master of Environmental Management degrees is made through the Office of Admissions of the School of Forestry and Environmental Studies. All correspondence should be addressed as follows: Director of Admissions and Financial Aid, School of Forestry and Environmental Studies, Duke University, Durham, North Carolina 27706.

Each applicant must submit the following before action can be taken:

1. application form;
2. transcripts from each undergraduate and graduate school attended;
3. three letters of recommendation;
4. scores on the aptitude (verbal, quantitative, and analytical) test of the Graduate Record Examination;
5. a nonrefundable application fee of $35.

Application Forms. No applicant will be considered until the completed application form and related documents are received by the director of admissions. The Admissions Committee attaches considerable weight to the statement of educational objectives submitted by the applicant. This statement should reflect well-defined motivation to pursue graduate study. The school is particularly interested in applicants who show leadership potential in the broad field of natural resources and the environment. Applicants are expected to demonstrate the maturity and sense of purpose essential to a demanding educational experience, including a concept of the value of professional education to the applicant's career plans and expectations.

Transcripts. Official transcripts of all undergraduate and graduate study should be sent directly to the director of admissions by the registrar of each institution attended.

Letters of Recommendation. Each applicant is required to arrange for the submission of three letters of recommendation, preferably on the form supplied with the application. These recommendations provide the Admissions Committee with evaluations of the applicant's past performance in academic and employment related situations. Although recommendations from any source are acceptable, at least one job related recommendation and one from a college instructor or administrator are desirable.

Graduate Record Examinations. All applicants for degree programs must take the aptitude test (verbal, quantitative, and analytical) of the Graduate Record Examination (GRE). Although not required, applicants are encouraged to take an advanced test and submit the score as additional information for admission. The GRE is administered by the Educational Testing Service at locations throughout the world. Applicants are urged to take the exam at the earliest convenient date. Scores on tests taken later than October may not reach the school until after the 15 February deadline for application for financial aid. Scores should be reported directly to the director of admissions. Registration forms may be obtained by writing to GRE, Educational Testing Service, Princeton, New Jersey 08540.

Application Fee. A nonrefundable application fee of $35 is required of all applicants. A personal check, money order, or cashier's check made payable to Duke University is acceptable. Applications will not be officially received or processed until the required fee has been paid.

Interviews. An interview with a member of the Admissions Committee is not required but may be helpful to the applicant as well as to the school. Consequently, those applicants who can visit the school are encouraged to do so. The interview presents an excellent opportunity for the applicant to ask questions, gain insight into the school, and bring items of concern to the attention of the Admissions Committee. Applicants are encouraged to allow sufficient time to visit classes, meet students and faculty, and tour the University and Duke Forest.

In general, interviews can be scheduled on weekdays throughout the academic year. Appointments should be made at least two weeks in advance. Visits during the summer months are possible but should be scheduled well in advance.

Each year faculty or other representatives of the school travel throughout the country to visit undergraduate schools. Applicants from the cooperative colleges should check with their program adviser for details of these visits. Applicants from other institutions interested in meeting with a representative of the school should write or call the director of admissions. In addition, it is sometimes possible to arrange an interview with an alumnus, particularly where distance precludes travel to Durham. In all of these situations the emphasis is on exchanging information with the applicant.

For further information or to arrange an interview, applicants may write to the director of admissions or call (919) 684-2135.

Deferred Admission. Normally, applicants are admitted only to the class for which they have applied. However, a deferral of admission may be granted for the applicant to gain experience or to strengthen academic qualifications for graduate study or for other valid reasons. Except in unusual circumstances, a deferral of admission cannot be granted for more than one year. Deferrals are granted on individual bases. The small size of each class frequently precludes open-ended guarantees of future admission; however, applicants with substantial reasons for deferring the start of graduate work are encouraged to send a request and a tuition deposit to the director

of admissions as soon as possible after receiving an offer of admission. Offers of financial assistance are cancelled upon deferral of admission and students must be reconsidered for financial aid.

Application Deadlines. Application forms and all other information required to complete the application and to allow a student to be considered for admission should be submitted to the Office of Admissions by 15 February for the fall term and by 15 October for the spring term. Although applications submitted after these dates may be considered, early application is recommended because the school receives applications from more qualified students than can be accommodated. All candidates should make arrangements to complete the Graduate Record Examinations well in advance of these deadlines. Applicants seeking financial assistance in the form of scholarships, fellowships, and assistantships for the fall term must have their applications completed no later than 15 February.

Response to Offer of Admission. When admission is approved, the applicant will receive an offer of admission and an acceptance form. A nonrefundable tuition deposit of $300 is required with acceptance of the offer. The admission process is not complete until the acceptance form and the tuition deposit have been returned to the director of admissions.

Additional Procedures for Foreign Students. Each year the School of Forestry and Environmental Studies welcomes a number of foreign students among its professional and graduate candidates. Applicants from other countries must meet the same criteria as applicants from the United States. All academic transcripts and other documents in support of admission must be accompanied by an official translation if the original document is not in English. The nonrefundable application fee of $35 (U.S.) must accompany the application. Applicants must have a fluent command of oral and written English. No allowance is made for language difficulty in arranging course schedules or in evaluating performance.

If the native language is not English, the applicant must submit scores on the Test of English as a Foreign Language (TOEFL) to be considered for admission. All arrangements for taking the TOEFL must be made directly with the Educational Testing Service, Box 899, Princeton, New Jersey 08540.

All foreign students whose native language is not English will be tested during their first registration period for competence in the use of oral and written English. Until such competence is determined, admission and arrangements for an award involving teaching must remain provisional. Students found to lack necessary competence should be prepared to assume all costs for being tutored in English and should reduce their course or research program by 3 units while being tutored. Students who do not successfully pass the test for competence in the use of oral and written English by the end of their first year of residency will not be permitted to continue their graduate work at Duke University.

Foreign students are not eligible for federal or state loans. The visa-granting authority in the student's country of origin, ordinarily the United States Embassy, requires proof that sufficient funds are available to the student to cover the expenses of all academic years of study before a visa can be granted. Current immigration laws make it extremely difficult for the foreign student to find summer employment and permanent employment in the United States after graduation.

Admission to the Graduate School

Applications for admission to M.S., A.M., and Ph.D. degree programs in forestry and environmental studies should be obtained from and returned to the Dean of the Graduate School, Duke University, Durham, North Carolina 27706. However, initial inquiries and questions concerning fields of study are best directed to the Director

of Graduate Studies, School of Forestry and Environmental Studies. In addition, prospective students are urged to write directly to professors whose research interests match their own to discuss opportunities.

Admission with Nondegree Status

Persons wishing to enter the School of Forestry and Environmental Studies as a nondegree student must submit a special application form calling for nondegree status along with an application fee of $20. The applicant must have completed a bachelor's degree from an accredited college or university and must submit an official transcript of all previous course work. The Graduate Record Examination is not required although the GRE score is helpful in the admissions process. The student must have one letter of recommendation; this letter should indicate why the applicant should be allowed to undertake nondegree study at Duke. The application itself requires a brief statement of purpose in which the applicant should state his or her reasons for such study at Duke.

School of Forestry and Environmental Studies—(area code 919) 684-2421
Dean's Office—684-2135
Graduate School—684-3913
Department of Housing Management—684-5813
Registrar—684-2813

Financial Information

Tuition and Fees*

The cost of graduate study in the School of Forestry and Environmental Studies at Duke is met primarily from income from endowment, gifts, grants, and research contracts. Substantially less than one-half of the total cost is covered by tuition. In general, the cost of a graduate education of the quality offered by Duke University is modest in comparison with that of other private institutions.

Estimated Expenses for the Academic Year. Certain basic expenditures, such as tuition and housing, are to be considered in preparing a student's budget. The following approximate costs, applicable in 1986–87, are indicative of costs that can be expected.

Tuition ($272 per unit)	$8,160
Student health fee ($101 per semester)	202
Housing	2,625
Food	1,980
Books and supplies	550
Motor vehicle registration	
automobile	30
motorcycle	15
Optional athletic fee	75

In addition to these necessary expenses, the student will incur others which will depend to a large extent upon the tastes and habits of the individual. The average Duke student, however, can plan on a budget in the range of $12,000 to $15,000 for the academic year. Travel costs, clothing purchases, and other major expenditures should be included in this estimate. Students with families naturally will have higher expenses.

Payment of Accounts for Fall and Spring. Monthly invoices for tuition, fees, and other charges are sent by the Office of the Bursar and are payable by the invoice due date; no deferred payment plans are available. As a part of the agreement of admission to Duke University, a student is required to pay all invoices as presented. If full payment is not received, a late payment charge as described below will be assessed on the next invoice and certain restrictions as stated below will be applied.

Late Payment Charge. If the *total amount due* on the student invoice is not received by the invoice due date, a penalty charge will be accrued from the billing date. The

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*The figures contained in this section are projections and are subject to change.

penalty charge will be at a rate of 1.34 percent per month (16 percent per annum) applied to the *past due balance*. The *past due balance* is defined as the previous balance less any payments and credits received during the current month. Student loan payments, if delayed for reasons beyond the individual's control, are treated as a credit on the student's invoice until the loan payment is received.

Restrictions. An individual will be in default of this agreement if the *total amount due* is not paid by the due date. An individual who is in default will not be allowed to register for classes, receive a copy of the academic transcript, have academic credits certified, be granted a leave of absence, or receive a diploma at graduation. In addition, an individual in default may be subject to withdrawal from the University.

Tuition Refund Policy. In the case of withdrawal from the University, students may elect to have tuition refunded or carried forward as a credit for later study according to the following schedule:

Withdrawal	Refund
Before classes begin	full amount
During first or second week	80 percent
During third, fourth, or fifth week	60 percent
During sixth week	20 percent
After sixth week	None

Tuition charges paid from grants or loans will be restored to those funds on the same pro rata basis and will not be refunded or carried forward. The schedule also applies to housing charges of students moving from University housing to off-campus housing. In the event of death, a full refund of tuition and fees will be granted.

Late Registration. Students who register at a date later than that prescribed by the University must pay a fee of $25 at the bursar's office.

Audit Fee. Students registered for a full course load may audit courses without charge. Otherwise, audit fees are $115 per course during fall and spring and one-half of tuition during the summer.

Transcripts. Transcripts are available on request for a fee of $2, payable in advance, for a single copy. Additional copies to the same address are fifty cents.

Housing Charges. Rent at Town House Apartments is $1,953 per person in a two-person, two-bedroom unit. Utility charges are not included.

Modular homes rent for $1,717 per person for a three-person, three-bedroom unit. Utilities are not included.

Central Campus Apartments rents are: $3,028 for a one-person efficiency unit; $2,308 per person in a two-person, two-bedroom unit; and $1,961 per person in a three-person, three-bedroom unit. Rent includes furnishings and utilities, but it does not include telephones.

Housing costs are subject to change prior to any academic year. A $100 deposit is required with all housing applications. This deposit only ensures a place on the housing waiting list and does not ensure any requested residence. The deposit is refunded if there is no room or if the applicant withdraws the application before an assignment is made.

Motor Vehicles. Motor vehicles parked on campus must be registered with the traffic office. Registration must be completed five days after operation on campus begins. The proper registration decal should be displayed on the vehicle. A registration fee of $30 is charged for each automobile and $15 for each motorcycle.

The following documents are required to register a vehicle: (1) valid state registration for vehicle registered, (2) valid state operator's license, and (3) satisfactory evidence of automobile liability insurance coverage with limits of at least $10,000 per person and $20,000 per accident for personal injuries and $5,000 for property damage, as required by the North Carolina Motor Vehicle Law.

Optional Athletic Fee. For the optional athletic fee, the student obtains admission to all regularly scheduled University athletic contests held on the University grounds during the academic year. This fee is payable at the beginning of the fall semester.

Student Health Fee. All students are assessed a fee for the Student Health Service. For the fall and spring, the fee is $202 ($101 per semester). For the summer, the fee is $35 per term.

Tuition and Fees for the Summer Session. Tuition during the 1987 summer session is $272 per unit (semester hour). The summer student health fee and audit fee are listed above. Further information on fees, housing, policies, and procedures related to the summer session is available from the summer session office, 121 Allen Building.

Financial Assistance

Financial assistance in the form of scholarships, fellowships, or assistantships is available for qualified students pursuing either the professional degrees (M.F. or M.E.M.) or the graduate degrees (A.M., M.S., or Ph.D.). The school is a participant in the Graduate and Professional Student Financial Aid Service (GAPSFAS). All scholarship and fellowship applicants must file application with GAPSFAS. Typically, a student may be offered either a scholarship or fellowship (to defray a part of the tuition) and an assistantship. Applicants may obtain a GAPSFAS form from a college or university counseling and placement center or from GAPSFAS, Box 2614, Princeton, New Jersey 08540.

Scholarships are granted from University funds which are in limited supply. Consequently, only well-qualified students can expect to receive awards. Scholarships are awarded on the basis of demonstrated outstanding academic ability and a high degree of professional promise. Most scholarship funds are awarded to students entering in the fall semester. Scholarships are nontaxable.

Fellowships are obtained from foundation grants, private industry, or individual donors. Donors of fellowship funds sometimes place restrictions on the use of the funds as well as on the amount of awards. Fellowships are awarded primarily to second- and third-year students on the basis of professional promise. Most fellowship recipients are directly involved in one of the academic programs of the school. These awards are nontaxable.

Assistantships are obtained primarily from grant and contract funds awarded to various faculty of the school. In addition, University-funded assistantships are available. Assistantships are awarded to students who have sufficient experience to contribute to one or more ongoing research programs. Assistantships at lower levels of support are awarded to first-year students whereas higher levels of assistantship support are awarded to more experienced second-year students. The Ph.D. candidate can expect to obtain financial support almost exclusively from sources external to the University. Depending on the student's work assignment, assistantships may be taxable.

In all instances, admission to the school is a prerequisite for the award of any form of assistance for the first year of study. Awards are not automatically renewed for the second year of study. Second-year awards are made on a competitive basis and students must reapply in order to be considered for an award.

Eligibility for Financial Assistance

A significant portion of the financial assistance for students in the School of Forestry and Environmental Studies is provided by federal, Title IV funds. To qualify for such funding, usually in the form of assistantships, grants, and loans, students must sign the certificate of compliance regarding Selective Service regulations and must maintain satisfactory progress toward their degree.

The definition of "satisfactory progress" is based upon a combination of length of study in the school, number of units completed, and grades received. The Master of Forestry and Master of Environmental Management degrees must be completed within five years after the first date of matriculation. (Candidates for the A.M., M.S., and Ph.D. degrees should consult the *Bulletin of the Graduate School* for comparable regulations.) During this time, the student must be enrolled for at least 9 units of credit each semester for the first four semesters and at least 3 units of credit per semester thereafter. Regulations concerning grades, stated elsewhere in this bulletin, are applicable.

Failure to maintain satisfactory progress will subject the student to probation or dismissal. A student on probation is ineligible for any form of financial assistance from the school until the terms of probation are removed.

SCHOLARSHIPS

University Scholarships. A limited number of scholarships are awarded each year to selected students who are pursuing either professional or graduate degrees. Awards are made on the basis of academic qualifications and professional or scientific promise. Stipends range from $1,000 to $7,000 for the academic year.

FELLOWSHIPS

Boise Cascade Corporation Fellowship. Fellowships are awarded each year to selected students who are pursuing a Master of Forestry degree in Forest Resource Management. Preference is given to qualified minority or female students. The stipends range up to $2,750 per year.

Champion International Foundation Fellowship. Fellowships are awarded each year to selected students who are pursuing a Master of Forestry degree. Stipends range up to $1,500 per year.

W. Horace Corbett Memorial Fellowship. Fellowships are awarded to selected master's or Ph.D. degree candidates. Stipends range from $1,000 to $3,000 per year for master's degree candidates and from $2,000 to $4,000 per year for students pursuing a Ph.D.

Forestry and Environmental Studies Alumni Association Fellowship. Fellowships are awarded each year to selected students who are pursuing a Master of Forestry or a Master of Environmental Management degree. The students must have completed one year of graduate study. The amount of the fellowships is set at $1,000 per year.

Daniel H. Gelbert and Associates Consulting Forestry Fellowship. A fellowship is awarded to a selected master's or Ph.D. degree candidate interested in the study of nonindustrial private timber holdings. The stipend is set at $2,000 per year.

Leroy B. George Fellowship. A fellowship is awarded to a selected student from the Haywood or Buncombe counties or the Hendersonville, North Carolina, school systems. Second preference is given to a student from the southern Appalachian region. If a qualified student cannot be identified within the region the fellowship may be awarded to a student in the school who has a demonstrated interest in resource and environmental education and planning. The amount of the fellowship is set at $1,000 per year.

John C. Glenn Fellowship in Land Resources. Fellowships are awarded to selected students pursuing the Master of Environmental Management degree. Stipends range up to $1,500 per year.

Integrated Case Studies Fellowship. Fellowships are awarded to selected students who present appropriate case study proposals in applied ecology. Stipends range up to $3,000 per year.

Andrew W. Mellon Foundation Fellowship. Fellowships are awarded each year to selected students pursuing master's or Ph.D. degrees. Stipends range from $1,000 to $5,000 a year.

Robert L. Smith Memorial Fellowship. A fellowship is awarded each year by the North Carolina Forestry Association to a selected student pursuing a Master of Forestry degree. The stipend is set at $500.

Southwest Forest Industries Fellowship. Fellowships are awarded each year to selected students pursuing a Master of Forestry degree. Stipends range up to $1,500 per year.

Raymond E. Sullivan Memorial Fellowship. Fellowships are awarded each year to selected students pursuing master's or Ph.D. degrees. Stipends range from $1,000 to $7,000 per year.

Frederick K. Weyerhaeuser Forest History Fellowship. This fellowship is available campus-wide to graduate students who wish to study broadly in the area of forest and conservation history. The annual stipend is $10,000. Inquiries should be made to the Forest History Society, 701 Vickers Avenue, Durham, NC 27701.

Union Camp Foundation Fellowship. Fellowships are awarded each year to selected students who are pursuing a master's degree in the Center for Resource and Environmental Policy Research. Stipends range up to $1,500 per year.

Weyerhaeuser Foundation Fellowship. A fellowship is awarded each year to a selected woman or minority student interested in a career in industrial forestry. The stipend is set at $3,500.

ASSISTANTSHIPS

Graduate Assistantships for the Master's Candidate. Available to both professional and graduate students, these assistantships are particularly suited to the student who is interested in working up to half time during the academic year and full time during the summer. Student assistants are employed to assist members of the faculty with their research and teaching, to assist members of the school staff, and to perform a variety of other functions such as gathering and assembling data on Duke Forest. A few assistantships are available for independent research on various grants and contracts of the school. By the nature of their academic program, particularly of the master's project, some students are able to combine academic study with employment as a graduate assistant.

Graduate assistants are required to work 300, 450, or 600 hours during the academic year. Those employed for 300 hours can expect to work approximately 10 hours per week allowing for University vacation periods. Those employed for 450 hours of service can expect to work approximately 15 hours per week, and those employed for 600 hours can expect to work for approximately 20 hours per week. All levels of service require a regular schedule to be arranged between the student and the faculty member to whom he or she is assigned.

Students employed for ten hours per week are limited to 15 units of credit per semester. Those employed for fifteen hours per week are limited to 12 units of credit, and those employed for twenty hours per week are limited to 9 units of credit per semester. Exceptions require the approval of the student's adviser and the dean. Only those students involved in research for their assistantship and those students involved in independent study or a master's project which is based on the research can expect to maintain an academic load in excess of 9 units.

The stipend for graduate assistantships requiring 300 hours of service is $1,800. Students employed for 450 hours earn $2,700 and students employed for 600 hours

earn $3,600. Depending on the nature of the work assignment, all or a part of the amount may be taxable.

A few graduate assistantships are available during the summer for research and teaching. Up to full-time employment of forty hours per week for a maximum of fifteen weeks is possible. Stipends range from $1,800 to $3,600, depending on qualifications and experience.

Graduate Assistantships for the Ph.D. Candidate. Students who are pursuing the Ph.D. may be retained on half-time service (1,200 hours) to the school during the calendar year. Graduate assistants are required to give 20 hours of service per week during the academic year. They may be retained for an additional 40 hours of service per week for fifteen weeks during the summer.

Typically, the Ph.D. candidate is assigned to a member of the faculty to work on a particular research project under his or her direction and/or to provide teaching assistance. Furthermore, the research undertaken is normally a part of the student's graduate program and serves as a basis for the doctoral dissertation. With few exceptions, assistantships are available only for the first two years of graduate study.

Graduate assistants are required to maintain a regular schedule of work as determined by the faculty member to whom each is assigned. Those accepting graduate assistantships will be limited to 10 units of course work per semester. Exceptions require the approval of the major professor and the dean.

Stipends for graduate assistants range from $7,200 to $9,600 for a calendar year of service (1,200 hours). Normally, only a small part of stipend is taxable.

Research Assistantships. Funded from grant and contract research under the direction of various members of the faculty, research assistantships provide support during the latter stages of study of the Ph.D. candidate. Typically, the research assistant completes one or more phases of a research project under the direction of the principal investigator, a member of the faculty. Normally, the research completed forms a substantial component of the requirements of the Ph.D. dissertation. However, in some instances this may not be the case and the students pursue dissertation research in a related area of study.

The level of service required of research assistants depends primarily on the nature of a particular research project and the availability of funds. Normally, research assistants are committed to 600 hours of service during the academic year (20 hours per week). Almost all research assistantships require full-time service for fifteen weeks during the summer. A regular schedule of research under the direction of the principal investigator must be maintained and the academic load is limited to a maximum of 9 units per semester. The research assistant who is retained for half-time service during the academic year and full-time service during the summer may earn from $7,200 to $9,600. Usually only a small part of the award is taxable.

Work/Study. Work/study funds are administered for student employment through the dean's office as assistantships. Students in the school are not eligible for work/study jobs administered through the University's placement office and are not awarded work/study funds in financial aid packages. Students who anticipate the need for a work/study position should complete the GAPSFAS form at the time they accept admission. They must also sign a form certifying that they are not in default to any student loan organization. Jobs are granted to those with established need and with the skill or training required by a professor for a particular type of teaching or research or by a staff member for a particular type of work. It is the responsibility of the student to inquire about jobs with individual faculty or staff and with the dean of the school.

Application for Awards for the Entering Student. Application for awards may be made concurrently with the application for admission. Applicants should initiate the

necessary action early to ensure that the required documents are filed with the dean of the school on or before 15 February prior to enrollment. Applicants should:

1. Complete the Graduate and Professional School Financial Aid Service (GAPS-FAS) form, sent on request.
2. Furnish the following documents: *(a)* official transcripts of all previous college or university credits earned, *(b)* letters of reference from at least three persons familiar with the applicant's character, scholarship, and professional ability, and *(c)* scores from the aptitude test of the Graduate Record Examinations. Applicants should plan to take this examination in October at the latest. Documents offered in support of admission, if so designated, may also serve in support of the application for financial award.

Notification and Acceptance of Awards. Recipients of awards are notified in late March. Completed applications received after the 15 February deadline will be considered if vacancies occur at a later date.

Scholarships, fellowships, and the various categories of assistantships provide the basis for professional/graduate student support. Once offered by the University or the school, funds are committed to one student and are therefore unavailable to others. *As a consequence, it is the policy of the school that all awards offered can be declined prior to 1 April without prejudice. However, offers accepted and left in effect after 1 April are binding for both the student and the school.*

Loans

Applications for loans will be considered after admission and scholarship decisions have been completed. New borrowers must first apply for loans through their state agency or local bank before other types of loans will be considered. The school also participates in the Federally Insured Student Loan (FISL) and National Direct Student Loan (NDSL) programs. Approval of loan requests for monies administered by Duke University is based on financial need and satisfactory scholastic standing. The school will make the decision on the type of loan the student receives—FISL or NDSL.

Applicants for all loans certified or administered by Duke University are required to file the form of the Graduate and Professional School Financial Aid Service (GAPS-FAS). Information and application material for GAPSFAS can be obtained by writing to Educational Testing Service, Box 944, Princeton, New Jersey 08540.

Applications and complete details regarding the loan programs can be obtained by writing to the school. All applications for loans should be made before 1 July preceding the academic year in which the student plans to matriculate.

State Guaranteed Loans. Most states have established guaranteed loan programs for their own residents. The terms of such loans, the methods of administration, and the availability of funds vary widely among the states. The school will supply information regarding the appropriate agencies to contact in each state and will also make the appropriate certifications of individuals applying for state guaranteed loans. Students requesting such certification must submit the GAPSFAS form.

Federally Insured Student Loan Program (FISL). A graduate student may borrow up to $5,000 per year to a maximum of $25,000, including amounts borrowed during the student's undergraduate years. The interest rate is 9 percent, but the student may qualify for an interest subsidy while still in school through determination of need on the GAPSFAS report. Six months after graduation or withdrawal from the University, interest and principal payments begin. The student has up to ten years for repayment. In order to be considered for a Federally Insured Student Loan, the FISL application should be completed.

National Direct Student Loan Program (NDSL). Loans through the National Direct Student Loan Program are administered by the University. The funds are allocated to the University under strict federal guidelines on parental income, reasonableness of budget, complete disclosure of assets, and independent status of the student. GAPSFAS must be submitted. Application may be made for up to $5,000. Interest on these loans begins to accrue at 7 percent six months after the student graduates or withdraws and repayment begins one month later with up to ten years to repay.

PLUS/ALAS Loan Program. Graduate students are eligible to borrow up to $3,000 through the federally sponsored PLUS/ALAS loan program. Applications are available through institutions granting the GSL, FISL, or NDSL. The interest rate for these loans may be higher than other federally sponsored loans and interest must be paid from the time the loan is granted. The principal, however, is deferred until graduation. Independent students may obtain the loan, with the only restriction being their ability to repay the interest. Dependent students must have their parents or guardians cosign the loan to guarantee repayment.

Federal Grant Programs. Students with only three years of study at one of the institutions in the Cooperative College Program may be eligible for undergraduate state and federal grant programs. Such students should consult their undergraduate financial aid officers, state loan agencies, or federal granting agencies for applications, requirements, and restrictions.

Short-Term Loans. Short-term loans and emergency funds are available through the E. S. Harrar Fund at a 12 percent interest rate. Application for a loan is made at the school's Office of Admissions and Financial Aid, 203 Biological Sciences. The funds are disbursed by the school's accounting office, 213A Biological Sciences, which also arranges terms for repayment.

Student Life

Off-Campus Housing

Most of the students at the school join the annual scramble to find a place to live off campus. About one-sixth live in on-campus apartment complexes owned by the University and in the graduate residence halls.

The University is very much a part of the urban environment that is Durham, but the campus is not an urban one. It is not traversed by streets with housing and businesses. Consequently the perimeter of the West Campus is densely developed with apartment complexes, and the East Campus is adjacent to a neighborhood of large early twentieth-century homes, some of which have been converted to apartments. Free bus service is available between the two campuses.

In August and early September, the Department of Housing Management operates an off-campus housing service which consists of a staff person who maintains listings of apartment openings, house rentals, and "roommates wanted." The off-campus housing service does not rate the quality of apartments, houses, or landlords, nor arrange viewings. Similarly, the director of admissions in the School of Forestry and Environmental Studies maintains a listing of houses and apartments popular with students in the school as well as a list of entering students who are interested in finding roommates. These lists are mailed to students during late summer.

University Housing

Town House Apartments. Town House Apartments is a thirty-two-unit complex of one- and two-bedroom apartments which houses single graduate and professional students. The complex is situated between the East and West campuses. Some of the apartments are furnished for occupancy by two single students and the remainder for three single students with two students sharing the large bedroom. Town House Apartments have one and a half baths, a living room, and kitchen with dining area. Students must arrange for and pay for electricity, gas, and telephone. The complex is air conditioned and has a swimming pool, and is easily accessible to the campus bus line. These apartments are available for continuous occupancy, summer months included, if desired.

Central Campus Apartments. In 1974 the University opened a 500-unit complex, the Central Campus Apartments. Units are available for single and married students. For single students, fully furnished one-, two-, and three-bedroom units are available. Apartments for married students include a few furnished efficiencies and one-, two-, and three-bedroom unfurnished units or units in which the living room and first bedroom are furnished. Married graduate students are given priority in these

apartments. Because of this and an expected turnover of about 25 percent annually, not all applicants may be accommodated at the time they desire. These units are available for continuous occupancy, summer months included, if desired.

Modular Homes. The University owns six modular homes which are located between East and West campuses. They are reserved for single students. These three-bedroom homes are equipped for three-person occupancy and have proved to be popular. They are usually reserved by students who have occupied other University accommodations during the previous academic year. Students arrange for and pay for electricity and phone.

Application and Residential Deposit. Application forms, housing information, and regulations governing the occupancy of rooms and apartments will be mailed when the Graduate School or School of Forestry and Environmental Studies has notified the Department of Housing Management of official acceptance of the student.

A residential deposit of $100 must accompany the application form but does not guarantee a space. This deposit is held throughout the term of the original occupancy and any subsequent renewal. In addition to the $100 residential deposit, a student currently residing in University housing and desiring to reserve accommodations for the next academic year or a shorter period must make a $100 prepayment of housing fees to the Office of the Bursar. The bursar's receipt must be presented to the Department of Housing Management at the time the application is made. This prepayment is refundable if a student withdraws from the University; has an approved leave of absence prior to 15 August and notifies the Department of Housing Management at that time; or cancels the application on or before 15 July.

Housing fees for single students are payable for an entire semester unless special arrangements to pay on a different basis are made with the University bursar. Married students may make monthly payments as required by the terms of the lease. Housing costs are listed in the Financial Information section.

Additional payments above the rates for the academic year are required for students who must arrive earlier than the dates established for occupancy or remain later than the dates established for vacating University housing.

Roommate matching is done by the Department of Housing Management on the basis of several questions on the application form. Appeals for changing roommates are accommodated at the conclusion of a semester.

Services for Students

Medical Care. The main components of the student health service include the University Health Services Clinic, located in the Pickens Building on West Campus, and the University Infirmary on the East Campus. Emergency transportation, if required, can be obtained from the Duke campus police. The facilities of the University Health Services Clinic are available during both regular and summer sessions to all full-time students. The facilities of the University Infirmary are available only from the opening of the University in the fall until graduation day in the spring to all currently enrolled full-time students.

To secure the benefits of the student health service, a graduate student, during the term or semester in which the illness occurs, must (1) in the summer session term be registered for at least 1 unit of research or 3 units of course work; (2) be registered for at least 9 units per semester. The costs of student health benefits have been borne by tuition in the past, but are now separate and can be identified as a medical expense for tax purposes. The student health fee is nonrefundable after the first day of classes. Students are not covered during vacations, and their dependents and members of their family are not covered at any time.

The resources of the Medical Center are available to all students and their spouses and children. Charges for all services received from the Medical Center are the responsibility of the student.

The University has an Accident and Sickness Insurance Plan available for full-time students. Although participation in this plan is voluntary, the University expects all graduate students to be financially responsible for medical expenses above those covered by the student health service. Students who have medical insurance or wish to accept the financial responsibility for any medical expense may elect not to join the Accident and Sickness Insurance Plan by signing a statement to this effect. Each full-time student in residence must purchase this student health insurance or indicate the alternative arrangement.

The Student Accident and Sickness Insurance Plan provides protection twenty-four hours a day during the twelve-month term of the policy. Students are covered on and off the campus, at home, while traveling, and during interim vacation periods. For additional fees a student may obtain coverage for a spouse or spouse and children. Term of the policy is from opening day in the fall.

Coverage and services are subject to change as deemed necessary by the University.

Counseling and Psychological Services. CAPS provides a comprehensive range of counseling and psychological services to assist and promote the personal growth and development of Duke students. The professional staff is composed of clinical social workers, psychologists, and psychiatrists experienced in working with young adults. Among services provided are personal, social, academic, and career counseling. A number of short-term seminars or groups focusing on skills development and special interests such as coping with stress and tension, fostering assertiveness, enriching couples' communication, and dealing with separation and divorce are also offered. A policy of strict confidentiality is maintained concerning each student's contact with the CAPS staff. Individual evaluation and brief counseling/therapy as well as career and skills development seminars are covered by student health fees. There are no additional charges to the student for these services.

Appointments may be made by calling 684-5100 or visiting CAPS, 214 Old Chemistry Building.

Office of Placement Services. The Office of Placement Services, 214 Flowers, acts as a liaison between the University and potential employers. Students who wish to register with the office are offered an opportunity to assemble a dossier of academic records and recommendations in preparation for interviews and to have a permanent file for future reference. Interviews with representatives from industry and government are scheduled throughout the year for those students who have registered with the placement office. All services are offered without charge to students and alumni. In addition, the school maintains its own Office of Placement and Internship, 207 Biological Sciences. For further information, see the Placement section in this bulletin.

International Adviser. The International House handles governmental matters for students from abroad such as statements of attendance for home governments, issuance of United States immigration forms for re-entry into the country after a temporary absence, and required yearly extensions of time. Any new student who is not a citizen of the United States should report with passport to the international adviser soon after arrival. The International House is located at 2022 Campus Drive.

Other Services. The Bryan University Center houses an information desk, two drama theaters, a film theater, stores for books and supplies, meeting rooms, lounges, snack bars, and other facilities. A barbershop, hairdresser, post office, and bank are also located in the center and in the nearby West Campus Union.

Student Organizations and Activities

Sports. Students are welcome to use such recreational facilities as the swimming pools, tennis courts, golf course, track, jogging course, handball and squash courts, gymnasia, weight room, and playing fields. Intramural programs provide an opportunity to participate in informal and competitive physical activity. A variety of clubs for gymnastics, scuba diving, sailing, cycling, badminton, karate, rugby, soccer, and crew are also active.

FOREM. The FOREM Club is the student organization for coordination of the school's social functions and intramural team participation. Annual functions of the club include a Christmas party, Christmas tree sale, Field Day, and year-end banquet.

Student Advisory Committee. The Student Advisory Committee, an elected student group, meets regularly with the dean and faculty representatives to offer advice on courses and curriculum, programs, and long-range goals of the school.

Professional and Scientific Societies. Students are encouraged to participate in one or more professional or learned societies appropriate to their academic interest. Many of these societies are interested in participation by students and offer a lower fee to encourage student membership. A student chapter of the Society of American Foresters is active in the school.

Religious Services. Interdenominational services are conducted on Sunday mornings in Duke Chapel. Roman Catholic masses are offered daily on campus. Several Protestant denominations have student centers on campus. The Divinity School conducts other chapel services and religious and social activities. There is also a Hillel group which meets regularly.

Cultural Activities. Concerts, recitals, lectures, plays, films, and dance programs are presented frequently on campus. Information on major events is available at Page Box Office or the Bryan Center information desk. The University Museum of Art, which has some excellent permanent collections, is located on East Campus.

Academic Regulations

Planning

The responsibility for the specific content of the academic plan of study rests with the student. A thorough familiarity with and understanding of the regulations contained in this bulletin as well as other sources provided by the school are essential to sound planning.

During the fall term each student is assigned a permanent faculty adviser. The adviser should be consulted in planning a course of study. Other members of the faculty, particularly those concerned with the plan of study, should also be consulted on an informal basis. Reassignment to another adviser can be obtained, but only by written request to the faculty council.

Registration

Entering students who register for the Master of Forestry or Master of Environmental Management degree will receive instructions by mail from the School of Forestry and Environmental Studies a few weeks before the start of the fall term. Registration should be completed during the orientation week. Students in residence register for succeeding semesters at times scheduled in the University calendar.

Registration is approved by the adviser and processed by the school's director of admissions and by the University bursar. Registration is required in order to take courses for credit or audit. To establish eligibility for University housing, for University loans and some outside loans, for the student health service, and for study and laboratory space, a student must be registered. All tuition and fee payments and any indebtedness must be settled before registration will be completed.

Late Registration. All students should register at the times specified by the University. The charge for late registration is $25.

Change of Registration. With approval of the adviser, the student can change registration for a period of ten days following the close of registration. A change of fees requires completion of a new fee sheet which is obtained from the school. *All changes of fees must be made on the first day of the ten-day change period.*

Refunds. Tuition refunds are governed by the policy stated in the chapter on Financial Information.

Graduate School Registration. Students in A.M., M.S., or Ph.D. degree programs register through the director of graduate studies of the Department of Forestry and Environmental Studies. Registration requirements and procedures are described in

the section on graduate degrees of this bulletin and in the bulletin of the Graduate School.

Reciprocal Agreements. Students enrolled full-time in the School of Forestry and Environmental Studies or in the Graduate School during the regular academic year may be admitted to a maximum of two courses per semester at the University of North Carolina in Chapel Hill, North Carolina State University in Raleigh, or North Carolina Central University in Durham. Similarly, graduate students in these schools may take up to two courses per semester at Duke. Students may also take summer courses at one of the reciprocating universities; however, they must also be registered for at least 1 unit of summer credit at Duke.

Immunization Requirement

The North Carolina immunization law requires students entering a college or university in the state to be immunized against the following diseases: measles, rubella, tetanus, diphtheria and, in some cases, polio. Each entering student is required to present proof of these immunizations in accordance with the instructions contained in the Student Health Services form provided with the student's matriculation material. This form should be completed and returned to Student Health Services prior to the student's first day of classes. Duke University cannot permit a student to attend classes unless the required immunizations have been obtained.

Courses

Course Descriptions. All courses to be offered at any time by the school are described in the final section of this bulletin. However, courses are subject to change. A list of courses to be offered during a particular term, as well as schedules of courses offered in other departments at Duke and at neighboring universities, are available from the director of admissions prior to registration for that term.

Independent Study. All students are expected to place increasing emphasis on independent study as they near completion of residence. FES 299 lists a number of independent project areas. Several students can work together under the supervision of a faculty member by registering for FES 200.

Master's Project. All students must complete a master's project of 4 to 8 credits. The project should be identified during the first term of study and initiated during the second term. No student will be permitted to register for the third term of study until a project proposal has been approved by the student's adviser and has been received in the dean's office. During the final two terms major emphasis should be placed on the project. In completing the project, the student applies theoretical and analytical training acquired during the two years of study on actual natural resource or environmental problems. If desirable, arrangements can be made by the student or the school for consultation with other organizations concerning the scope and objectives of the project.

Students maintain close contact with their advisers during the development and writing of the master's project. Projects should reach final stages of completion by midterm of the final semester in residence. *One copy of the project, approved by the adviser, must be delivered to the dean's office by 1 November for those graduating in December, by 1 April for those graduating in May, and by 1 August for those graduating in September.* The adviser is responsible for critical assessment and grading.

Auditing. Students registered for a full course load may audit courses free of charge. Otherwise, the audit fee is $115 per course during the fall and spring and one-half of tuition during the summer. Written permission of the instructor prior to registration for the course is required. Audited courses must be so indicated on the

registration card. In classes where enrollment is limited, students enrolled for credit will receive priority. Audited courses are recorded without grade on the student's permanent record card. Regular attendance is expected. Changes from audit to credit are not permitted after the drop/add period.

Dropping and Adding. The period for dropping and adding courses is limited to the first ten calendar days of the fall and spring semesters. During the summer, dropping or adding of courses is limited to the first three days of the term. Students are advised to make all class changes on the first day of class if at all possible. *Except under unusual circumstances, and with special permission of the dean, no reduction of tuition and fees is permitted unless classes are dropped on the first day of the drop/add period.*

For the special intensive courses, registration may be changed from one intensive course to another course of equal credit after the close of the drop/add period. However, there may be no change in the number of semester hours or in fees.

Retaking Courses. Courses required as a part of the program elected by the student or required by the adviser must be retaken if failed. Courses prerequisite to more advanced courses the student wishes to elect must be retaken if failed. Elective courses may be retaken if the student wishes to do so. See the section on grades, below, for additional information.

Credit Hours

Students are considered fully registered when they enroll for the number of credits their programs require. Required registration is set in consideration of the student's obligation to teach or assist and of the student's progress toward fulfilling degree requirements. In the academic year, maximum registration for the resident student who does not hold an appointment as a graduate or research assistant and does not engage in part-time work is 15 units a semester or 30 units an academic year. The registration for resident students who hold such appointments or undertake such work is either 12 or 9 units, depending on the number of hours per week they are required to devote to such duties.

A full semester load of 15 units normally consists of a combination of regular courses, independent projects, and the master's project for not more than 13 units, plus 2 units of seminars or modular courses. No more than four regular courses can be taken in a semester. Permission of the dean is required to take more than 15 or less than 9 units in a semester.

Summer Registration. Students who are in residence during the academic year and wish to continue to study and to use University facilities during the summer, including the student health service, must register for 1 unit in the first summer session term. This registration provides use of facilities for both terms of the summer session.

Registration in Residence Versus Registration in Absentia. A resident student who has completed all requirements except the master's project must register for 3 units of credit each semester during the regular academic year until all degree requirements are met. A student who decides to study away from the University may register for 1 unit of credit in absentia with permission of the dean. A student working toward a degree must be registered either in residence or in absentia each fall and spring semester until completion of the degree. Only under extreme circumstances (serious problems of health) may this requirement be waived.

Grades

The grading system used in the School of Forestry and Environmental Studies and the Graduate School is as follows: E (exceptional); G (good); S (satisfactory); F (failing); I (incomplete); Z (continuing).

The grades of *P* (pass) and *F* (fail) are used in the School of Forestry and Environmental Studies for seminars and modular courses. At the instructor's option, the grades of *P* or *F* or regular letter grades are used for intensive courses, independent projects, and master's projects. The grade of *Z* is assigned for an independent project or a master's project which extends over a period of more than one semester; a final grade is given upon completion of the project. Credit hours for a course completed on a pass/fail basis are creditable toward the master's degree as long as the course is not required in the student's major area of study. Permission for the pass/fail option must be obtained in writing from the instructor upon registration for a course.

Incomplete Grades. A grade of *I* indicates that some portion of the student's work is lacking, for an acceptable reason, at the time grades are reported. Requirements of all courses in which a grade of Incomplete is assigned by an instructor must be fulfilled within one calendar year following the date of the assignment of the incomplete grade. If the student fails to complete the requirements within one calendar year, the *I* grade will be changed to a grade of *F*.

In exceptional circumstances, upon recommendation of the professor who assigned the grade of Incomplete, the faculty council may extend the time for completion of the course requirements. If, in the judgment of the professor and the student's adviser, completion of the requirements is not a reasonable alternative for the student, the student may petition the faculty council to allow the grade of *I* to stand permanently on his or her record. Action to allow the *I* to stand permanently must be initiated prior to the time that a grade of *F* is recorded (i.e., within one calendar year). No student will be allowed to graduate with an Incomplete unless permission has been granted for it to stand permanently on the record.

Failure. Any course for which a failing grade is received must be retaken or replaced with a substitute course. A substitute course requires the approval of the student's adviser and the faculty council. Both the original failing grade and the grade received for the retaken or substitute course will appear on the student's transcript. Failure of a course also subjects the student to dismissal (see the sections on probation and dismissal and automatic dismissal).

Probation and Dismissal. Students are subject to dismissal from the school under any one or a combination of the following factors:

1. no grades higher than *S* during the first semester of study;
2. less than 6 units of *G* and/or *E* grades during the first full year of study;
3. a grade of *F* in any course at any time.

An appeal may be submitted through the adviser to the faculty council to continue study under a probationary status. Probationary terms, set by the adviser, must be specific in the appeal and the appeal must be approved by the faculty council. If probationary terms are met, the student will be returned to regular status. If probationary terms are not met, the student will be dismissed. Students will not be awarded degrees while on probationary status.

Automatic Dismissal. A student is automatically dismissed upon failure of more than one course.

Academic Irregularities

All cases falling outside the regular policies and procedures of the school are referred to the faculty council for decision. The work of the council includes review and decision regarding course requirements for graduation, student probation and withdrawal, student petitions for waivers of degree requirements, and all actions which deviate from established academic regulations.

A student who desires to petition the council should do so in writing to the chairman. A precise statement of the reason for the request is required. The student will be notified in writing of the decision of the council by the chairman.

Transcripts of Credit

A student who is registered for a course and who successfully completes the requirements as prescribed by the instructor receives credit on the records of the school. Official transcripts of credit are issued only by the University Registrar, 103 Allen Building. Requests for transcripts, sent directly to the registrar, should state clearly the full name under which the work was taken, the dates of attendance, and to whom the transcripts are to be sent. The student must sign the request for release of a transcript. The cost of a single transcript is $2, payable in advance. Additional copies to the same address are 50¢ each. No transcripts will be issued for students who fail to clear all financial obligations to the University upon graduation.

Length of Study

For a full-time student entering without an undergraduate degree in forestry or environmental studies, the normal time for completing the master's degree is four semesters. No student, either full-time or part-time, is allowed more than five years to complete the requirements for the master's degree.

Withdrawal

A student is required to be registered each semester of each academic year either in residence or in absentia until all degree requirements are satisfied. A student is considered to be working toward a degree until he or she submits in writing a formal request to the faculty council. The petition must state the reasons for withdrawal and the projected time of departure from the University. Until formal notice of withdrawal is accepted by the faculty council or the student completes the degree, a registration card for each semester of the academic year for up to three years will be prepared to register the student in absentia. The student will be required to pay for such registrations and any resulting late fees even if the student later withdraws from the University. Such bills and their collection will be under the authority of the University bursar.

Application for the Degree

Even if degree plans are tentative, a candidate for a degree must file an application for the degree no later than the end of the sixth week of the semester in which the degree is to be received. For a degree to be awarded in September, application must be filed no later than the beginning of the second summer session. The application for the degree is valid only for the semester in which it is filed. If the student does not receive the degree as expected, he or she must file a new application.

All candidates are urged to attend the commencement exercises at which their degrees are to be awarded. A student who is unable to attend is required to file a petition with the dean, not later than four weeks prior to commencement, seeking permission to receive the degree in absentia.

Debts

Students are expected to meet all financial obligations to the University prior to completion of the degree. Failure to pay all University charges by the due dates

specified by the University will bar the student from registration, class attendance, receipt of transcripts, certification of credits, leave of absence, or graduation until the account is settled in full. Further, an individual in default may be subject to withdrawal from the University.

Courses of Instruction

Course offerings are subject to change. The student should consult the current University course schedule for listings of courses to be offered each semester.

Introductory Courses

191, 192. Independent Study in Forestry and Environmental Studies. Directed reading and research. Open to qualified students in junior and senior years by consent of the student's department in Trinity College and of the School of Forestry and Environmental Studies. Units to be arranged. Fall, spring, summer. *Staff*

194. Conserving Natural Resources. Fundamentals of natural resource development, use, management, and protection based on principles of the natural and social sciences. Open only to undergraduates. 3 units. Spring, on demand. *Staff*

Forest Resource Management

204. Forest Inventory, Growth, and Yield. Measurement of land and forests for purposes of management, appraisal, purchase, and sale. Techniques for predicting the growth and future yield of stands by various methods. 3 units. Fall. *Davison*

205. Silviculture. Consideration of the decision-making process by which prescriptions are formulated for regeneration, tending, and harvesting of forest stands. Biological factors underlying stand manipulation are stressed and economic, harvesting, and utilization variables are discussed as appropriate. Emphasis on principles and techniques that transcend vegetation types or geographic regions. 4 units. Spring. *Oren*

207. Forest Pest Management. Fundamentals of entomology and plant pathology as appropriate to understanding the impacts of insects and diseases on forest productivity and their assessment for integration into forest management. Regional case examples and complexes are evaluated in terms of pest-population, forest-stand dynamics; economic and societal constraints; treatment strategies; monitoring systems; and benefit-cost analysis. This approach seeks to develop predictive capabilities in long-range pest management and decision making. Laboratory is largely field oriented to focus on diagnostics and impact analysis. 3 units; 4 units with laboratory. Fall. *Stambaugh*

208. Fire Behavior and Use. Impacts of destructive agents upon forests; principles of combustion, fire behavior, danger measurement and suppression; use of fire in forest management. 3 units. Spring. *Staff*

210. Forest Pathology. Diseases of North American forests and their timbers, with emphasis on current literature and management strategies. Field and laboratory diagnosis. 3 units; 4 units with laboratory. Offered on demand. *Stambaugh*

221. Forest Soils. Introduction to soil resources and the interactions of forest production, management, and soil fertility. Topics include soil chemistry, physics, development, and nutrient cycling, all from the perspective of maintaining and improving forest productivity. 3 units. Spring, odd-numbered years. *Binkley*

261. Remote Sensing for Resource Management. An examination of remote sensing systems as sources of information in resource management with an emphasis on aerial photography and multispectral scanners. Emphasis on the interpretation of airborne and space imagery. 3 units. Spring. *Davison*

262. Forest Utilization. Introduction to utilization in the managed forest and the principal wood-using industries. Taught as a one-week field seminar. May be taken by nonforestry majors. 1 unit. Spring. *Staff*

263. Harvesting and Transportation Systems. Analysis of cable, tractor, and aerial harvesting systems. Sawlog and pulpwood transportation. Emphasis on material flow, inventory control. Application of simulation and optimization methods to harvesting, loading, and transport. 3 units. Offered on demand. *Jayne*

264. Manufacturing Systems. Study of material processing in sawmills, pulpmills, plywood plants, and composite board manufacturing facilities. Emphasis on material flow, quality control, inventory control. Application of quantitative methods and economic analysis to forest product manufacturing operations. 3 units. Offered on demand. *Jayne*

301. Forest Nutrition Management. Basic processes of soil chemistry and ecosystem nutrient cycling as regulators of forest production. Management impacts such as fertilization, fire, harvest, and biological nitrogen fixation. Laboratories include methods of determining site fertility, assessing forest productivity, and using computer simulation models to guide management decisions in forest nutrition programs. 4 units. Offered on demand. *Binkley*

305. Harvesting Effects on Productivity. Impacts of harvesting on the residual stand, soil properties, water quality, and future site productivity. The integration of harvesting into overall stand management through a full rotation is stressed. 2 units. Fall, on demand. *Davison*

308. Tree Biology. Life processes and properties of trees, including anatomy, physiology, and chemistry. Focuses on the tree as an integrator of ecological site factors in the production of value from the forest. 2 units. Offered on demand. *Staff*

309. Forest Regeneration. Natural and artificial means of creating new forest stands of desirable quality and stocking. Biological, economic, and technical factors are considered. Prerequisite: 205. 2 units. Offered on demand. *Staff*

322. Microbiology of Forest Soils. Ecology of the microbial populations of forest soils, with emphasis on rhizosphere interactions, root pathogenesis, and mycorrhizae. Prerequisite: consent of instructor; mycology and bacteriology are recommended. 4 units. Offered on demand. *Stambaugh*

361. Forest Resource Management. The integration of biologic, socioeconomic, and environmental constraints in planning, organizing, and managing forest properties for maximizing production of timber and other benefits. Emphasis on analysis of growth and yield for regulation of growing stock; application of economic imperatives in decision making, including valuation of forest land and related resources; and use of microcomputers in simulating management options. Students develop and

present a viable management plan for a portion of the Duke Forest. Prerequisites: 204, 205. 4 units. Spring. *Parks and MacKinnon*

367. Seminar in Forest Resource Management. Examination of concepts, practices, and policies employed in the management of industrial and public forests; discussion of the problems of large-scale forest management. Offered since 1985-86 as the Laird, Norton Distinguished Visitor Series. 1 unit. Spring. *MacKinnon*

Resource Ecology

211. Applied Ecology and Ecosystem Management. An application of ecological principles to applied resource and environmental problems with an emphasis on the ecosystem as a basic working unit. Perspectives include such topics as land/water interactions, the patchiness concept, succession, energy flow, productivity, mineral cycling, perturbation effects on ecosystems, and limiting factors. Laboratory studies will focus on the team approach to analyzing the biotic and abiotic components of the ecosystem and impact analysis. 4 units. Fall. *Richardson*

213. Forest Ecosystems. Introduction to basic processes regulating ecosystem development, structure, and function leads to examination of ecosystem concepts and the effects of management activities on ecosystem processes and patterns. Elective laboratory, taught as FES 214, introduces field aspects of forest ecology. 3 units. Fall. *Binkley*

214. Ecology of Southern Appalachian Forests. One-week introduction to forest ecosystems in the southern Appalachians, including species identification, major forest types, patterns in ecosystem distributions, and effects of human activities. 1 unit. Fall. *Binkley*

215. Environmental Physiology. Examination of the concepts of tolerance, limiting factors, bioenergetics, nutrition, stress physiology, homeostasis, and alleopathy for both plant and animal life. Discussion of procedures for and examples of monitoring physiological perturbations due to resource manipulation. 3 units. Spring, even-numbered years. *Richardson and Di Giulio*

216. Applied Population Ecology. Discussion of population dynamics of natural and exploited populations. A quantitative approach with an emphasis on mathematical models and their application to population problems. 3 units. Spring, odd-numbered years. *Maguire*

218. Barrier Island Ecology. Adaptation of plants to barrier island migration and other physical characteristics of the coastal environment. Major emphasis will be placed on management of barrier beaches from Maine to Texas and the impact of human interference with natural processes. Field studies. Prerequisite: course in general ecology. Offered at the Duke Marine Laboratory, Beaufort, North Carolina. 6 units. Summer, term 1. *Godfrey*

267. Wildland and Wildlife Management. Overview of wildlife management in relation to land use, properties of wildlife populations, elements of game range, manipulation of food and cover, agencies involved in wildlife conservation, and the role of public and political involvement. 3 units. Spring, on demand. *Staff*

311. Ecological Toxicology. Study of environmental contaminants from a broad perspective encompassing biochemical, ecological, and toxicological principles and methodologies. Discussion of sources, environmental transport and transformation phenomena, accumulation in biota and ecosystems. Impacts at various levels of organization, particularly biochemical and physiological effects. Prerequisites: organic chemistry and vertebrate physiology or consent of instructor. 3 units. Fall. *Di Giulio*

312. Wetlands Ecology. The study of bogs, fens, marshes, and swamps. Emphasis on processes within the ecosystem: biogeochemical cycling, decomposition, hydrology, and primary productivity. Ecosystem structure, the response of these systems to perturbations, and management strategies are discussed. A research project is required. Prerequisites: 211 or equivalent and consent of instructor. 3 units. Spring, odd-numbered years. *Richardson*

314. Integrated Case Studies in Toxicology. Students are assigned topics relative to their chosen research discipline in toxicology and are asked to develop case studies to present at a roundtable workshop. Emphasis on review and analysis of toxicological problems from a holistic (multidisciplinary) viewpoint. 1 unit. Spring, on demand. *Richardson*

316. Case Studies in Environmental Management. Introduces an integrated ecological, economic, and sociopolitical approach to solving resource management problems. Students work in groups to analyze local problems and present their results. Emphasis on setting goals for research, project organization, selection of quantitative tools, preparation of written and oral presentations. Prerequisites: 211 and 251 or equivalents. 4 units. Spring. *Staff*

318. Seminar in Ecotoxicology. Discussion of current topics concerning environmental contaminants. Individual students review a chosen topic and lead subsequent discussion. Guest speakers. 1 unit. Spring. *Di Giulio*

325. Ecologic Effects of Acidic Deposition. Impacts on both terrestrial and aquatic ecosystems are examined by reviewing key chemical processes, evaluating case studies, reviewing current literature and research projects, and through discussions with visiting experts. 3 units. Spring, even-numbered years. *Binkley*

Water and Air Resources

230. Weather and Climate. Overview of the science of meteorology and principles of climatology, especially as applied to problems in ecology and natural resource management. Emphasis on the processes and characteristics of weather phenomena and local and regional climates. General introduction to sources of climatic data and climatic data analysis. Includes laboratory. 4 units. Fall. *Knoerr*

231. Environmental Climatology. Applications of climatology to solving problems in the areas of applied ecology; land use planning; forest, water resource, and air quality management. History of the atmosphere and world climates is considered to provide a perspective on current conditions. Impact of weather on human behavior, property, and natural resource management. 3 units. Spring. *Staff*

232. Microclimatology. Introduction to the micrometeorological processes. Discussion of the integration of these processes and the resulting microclimates in the rural (forest, field, and water surface) and urban environments. Methods for modification of the microclimate. 3 units. Spring, on demand. *Knoerr*

234. Watershed Hydrology. Introduction to the hydrologic cycle with emphasis on the influence of land use, vegetation, soil types, climate, and land forms on water quantity and quality and methods for control. Development of water balance models. Analysis of precipitation patterns, rainfall and runoff, and nonpoint source impacts. Statistical handling and preparation of hydrologic data, simulation and prediction models, introduction to groundwater flow, laboratory and field sampling methods. 4 units. Fall. *Marin*

236. Water Quality Management. Types, sources, and effects of pollutants. Water quality standards and criteria. Engineering approaches to water management. Mathematical models and their application to water quality management. Federal regula-

tions, in particular, the Federal Water Pollution Control Act amendments of 1972 and 1977. Economic and policy analysis for water quality management planning. 4 units. Fall. *Reckhow*

237. Watershed Modeling and Management. Analysis of models for individual hydrologic processes. Evaluation of management-oriented watershed models based on the hydrologic process models. Simulations with watershed models as a basis for management decision making to optimize water yield quantity, timing or quality under various vegetative, climatic, topographic, and soil conditions. Prerequisite: 234. 3 units. Spring. *Knoerr and Marin*

330. Environmental Monitoring and Instrumentation. Methods of measuring and monitoring the earth's physical environment with emphasis on water and air resources. Characteristics and uses of contemporary sensors, measurement and data acquisition systems. Methods of obtaining and processing computer compatible data records. Includes laboratory. 4 units. Spring, on demand. *Knoerr*

331. Water Resource Systems. Introduction to the fundamentals of water resource systems planning and management. Emphasis on optimization, simulation, statistical, and economic principles for management of surface and subsurface water resources. Topics include project selection and evaluation, design of standards and regulations, stochastic and deterministic quantity/quality simulation models, water supply and waste water treatment technologies, decision and risk analysis. 3 units. Spring. *Marin*

332. Air Quality Management and Modeling. Types and sources of atmospheric contaminants including effects of industry, urban development, farming and forestry practices, and recreation. Meteorological effects on air quality. Determination of air quality trends and the application of management systems from a meteorological point of view. Types and applications of air quality models. Performance of air quality models under various emission sources, meteorological, and topographic conditions. 3 units. Fall. *Staff*

335. Water Quality Modeling. Development and evaluation of simulation models of surface water quality. Mechanistic descriptions of aquatic ecosystems and materials transport. Parameter estimation. Methods of solution, including uncertainty analysis. Prerequisites: 234, 236, 350, 355. 3 units. Fall, odd-numbered years. *Reckhow*

Quantitative Methods

251. Natural Resource Data Analysis. Students learn how to develop and choose models for use in forestry decisions, analyze the results, evaluate validity and utility, and interpret models developed by others. Emphasis on silviculture models for timber, wildlife, water, recreation, and cash flow. 3 units. Fall. *Boyce*

302. Models in Forestry. Students learn how to develop and choose models for use in forestry decisions, analyze the results, evaluate validity and utility, and interpret models developed by others. Emphasis on silviculture models for timber, wildlife, water, recreation, and cash flow. 3 units. Fall. *Boyce*

350. Applied Regression Analysis. Regression analysis with nonexperimental data using ordinary least squares. Emphasis on assumption violations: consequences and correctives. Analysis of variance and time series analysis using Box-Jenkins methods as time permits. Applications to problems in natural resource management. Prerequisite: 251 or equivalent. 4 units. Spring. *Reckhow*

355. Optimization Methods for Resource Management. Introductory survey of optimization techniques useful in resource management and environmental decision making. Numerical techniques for unconstrained optimization, linear programming,

dynamic programming, and optimal control methods. Prerequisite: consent of instructor. 3 units. Fall. *Staff*

357. Systems Ecology and Modeling. Concepts of systems analysis and simulation modeling in ecology. Examples emphasize use of systems analysis and modeling to solve environmental management problems. Prerequisites: ecology, introductory statistics, computer programming on microcomputer and TUCC; additional quantitative background desirable. 3 units. Spring, even-numbered years. *Maguire*

385. Decision Theory and Risk Analysis. Bayesian decision theory, including probability, subjective probability, utility theory, value of sample information, and multiattribute problems. Behavioral decision theory. Applications of de cision theory in resource and environmental policy making. Prerequisite: 251 or equivalent. 3 units. Spring, even-numbered years. *Reckhow and Maguire*

Resource Economics and Policy

269. Business Aspects of Natural Resources. Introduction to various business and financial aspects crucial to decision making in the management of natural resources. Specific topics include concepts of managerial accounting, corporate financial statements, measurement and projection of business results, sources of funds and analysis of capital investment decisions, risk and uncertainty in decision making, and survey of computer models used in these areas. Extensive use is made of case studies, problem solving, and group discussions. Prerequisite: 270. 3 units. Fall. *MacKinnon*

270. Resource Economics and Policy. The application of economic concepts to private and public sector decision making concerning natural and environmental resources. Investment analysis, benefit-cost analysis. Planning and policy concepts. Prerequisite: introductory course in economics. 4 units. Spring. *Hyde*

283. Environmental Policy and Values. Discussion of varying philosophical approaches to the allocation and use of natural resources and the environment. Views espoused by ecologists, preservationists, naturalists, conservationists, economists, planners, theologians, lawyers, and political scientists are considered. Through extensive readings, students consider who values what in society, and who gets what, when, and how. Prerequisite: consent of instructor. 3 units. Fall. *Royer*

363. International Trade and Forest Investment. Overview of world trade patterns in both raw and manufactured forest products in the context of international trade theory. International trade and foreign investment policies affecting natural resource based activities. Long- and short-term supply and demand outlooks for the major producing, potentially producing, and consuming nations are considered in terms of natural resource endowment and investment efficiency. International efforts to develop worldwide supply-demand equilibrium models for forest products. 3 units. Spring. *Yoho*

372, 373. Advanced Natural Resource Economics. Survey of advanced topics in natural resource and environmental economics. Emphasis on renewable resources and public policy. Prerequisite: consent of instructor. Two courses, 3 units each. Fall and spring. *Hyde*

381. Natural Resource Policy. An examination of institutions and processes in the public sector that influence natural resource allocation and use of the environment. Emphasis on political allocation of resources, especially legislative and administrative processes. Topics include the roles of democracy and free enterprise, lobbying, public participation, planning, and advocacy. Prerequisite: consent of instructor. 3 units. Spring. *Royer*

388. Seminar in Resource and Environmental Policy. Discussion of the political, legal, and socioeconomic aspects of public and private action in environmental quality control and management. Prerequisite: consent of instructor. 1 unit. Fall, spring. *Staff*

389. Seminar in Forest and Conservation History. Evolution of resource agencies, forest industries and associations, and conservation/environmental organizations. Public policies for land and resources are compared with priorities and constraints in the private sector. Prerequisite: consent of instructor. 2 units. Spring, odd-numbered years. *Steen*

Intensive Courses

258. Forest Appraisal. Presentation of the principles of real estate appraisal as they apply to valuation problems in forestry. Consideration of appraisal theory, accounting and tax concepts in forest land management. Application of financial analysis techniques to forest land management through lectures and problem-solving sessions. 3 units, intensive. Fall. *Sizemore*

268. Resource Management and Business Practices. Presentation of various aspects of managerial accounting and financial analysis crucial to decision making in the management of natural resources. Consideration of corporate financial statements, sources and uses of funds, breakeven analysis, measurement and projection of business results. 1 unit, intensive. Fall. *MacKinnon*

280. Economics in Forest Planning and Program Implementation. The role of economics in planning in public and private forest organizations. Emphasis on analysis of goals to develop decision criteria for budget formulation and project selection. 1 unit, intensive. Fall. *Row*

288. Forest Taxation. Review of the principles of timber taxation as applied to forest management, including income (capital gains), estate and property taxation. Types of timber transactions discussed include outright sales, cutting contracts, and leases. Proper treatment of expenses, depletion basis, and casualty losses are considered. Emphasis on solution of practical problems using actual reported cases. 1 unit, intensive. Fall, spring. *Condrell*

306. Choices in Silviculture. Simulation of the financial aspects of silvicultural practices when used to produce timber, wildlife habitat, water, range, and recreational benefits; economics of production; and trade-offs for multiple benefits. Students use actual forest inventories to devise silvicultural strategies, which are simulated with the system dynamics models DYNAST and STELLA on microcomputers. 1 unit, intensive. Fall. *Boyce and Easterling*

366. Mathematical Modeling of Lake and Reservoir Water Quality. Practical application of mathematical models of lake and reservoir water quality. The major objective is to expose the participant to a wide variety of techniques that are useful in predicting the responses of lakes and impoundments to pollutants. Statistical and mass balance models are included. Knowledge of elementary calculus and statistics is recommended. 1 unit, intensive. Fall. *Reckhow and Chapra*

370. Economics of Intensive Forestry. Analysis of investment in intensive forestry and comparison of alternative uses of land and capital. Methods commonly used to determine financial returns: financial maturity, present net value, internal rate of return, cash flow and benefit-cost calculations. 1 unit, intensive. Spring. *Vasievich*

375. Timberland Investment Analysis. Investment characteristics of timberlands, particularly with reference to institutional investors. Consideration of investment objectives (preservation of capital, return on investment, liquidity) and constraints

(taxes, accounting conventions, legal requirements). 1 unit, intensive. Spring. *Mason and Howard*

383. Natural Resources Conflict Management. Current issues in the natural resources field and methods of solution, including conflict avoidance, joint planning, mediation, conciliation, public participation, and consensus building. 1 unit, intensive. Spring. *Busterud*

384. Special Tax Problems for Industrial Timberland Owners. Current problems of industrial timber taxation including the use of subsidiaries in sales, Internal Revenue Service audits, valuation, financing of land, and casualties. Prerequisite: 288 or equivalent experience. 1 unit, intensive. Fall. *Condrell*

386. Problem Solving Processes and Management Concepts: The Individual and the Team. Course designed to improve the management skills of the participants. Emphasis on identification of problem type (planning problem, decision problem, or cause and effect analysis) and application of appropriate solution processes. Focus on participatory management, communication skills, and time management/stress management concepts. 1 unit, intensive. Fall. *Banzhaf*

Special Studies and Projects

200. Student Projects. A group of five or more students may plan and conduct their own research project on a special topic, not normally covered by courses or seminars. A request to establish such a project should be addressed to the faculty council with an outline of the objectives and methods of study and a plan for presentation of the results to the school. The faculty council will designate the units to be earned and a faculty member for the evaluation and grading of the work of each participant. Fall, spring, summer.

201. Field Studies. Visits to and studies of resource use and management areas and activities outside the University. Variable registration fee. Units to be arranged. Fall, spring, summer. *Staff*

299. Independent Projects. Directed readings or research at the graduate level to meet the needs of individual students. Units to be arranged. Fall, spring, summer. Students should register for the course number listed below for the supervising faculty member.

299.1 *Binkley*	299.17 *Reckhow*
299.2 *Boyce*	299.18 *Richardson*
299.3 *Bentley*	299.19 *Royer*
299.4 *Alig*	299.20 *Sizemore*
299.5 *Davison*	299.21 *Parks*
299.6 *Di Giulio*	299.22 *Stambaugh*
299.7 *Dutrow*	299.23 *Steen*
299.10 *Heath*	299.25 *Yoho*
299.11 *Hyde*	299.27 *Christensen*
299.12 *Jayne*	299.28 *Condrell*
299.13 *Knoerr*	299.29 *Vesilind*
299.14 *Marin*	299.30 *Healy*
299.15 *Maguire*	299.31 *MacKinnon*
299.16 *Dieter*	299.33 *Oren*

398. Program Area Seminar. Required seminar in each of the four program areas. Students present master's project research. 1 unit. Spring. *Staff*

399. Master's Project. An applied study of a forestry or environmental management problem or a theoretical research effort. A seminar presentation of the objectives, methodology, and preliminary findings is required. A written (or other medium) report at the conclusion of the project is also required. Units to be arranged. Undertaken with the guidance of the student's adviser. Fall, spring, summer.

Numerical Listing of Courses

191,192. Independent Study in Forestry and Environmental Studies
194. Conserving Natural Resources
200. Student Projects
201. Field Studies
204. Forest Inventory, Growth and Yield
205. Silviculture
207. Forest Pest Management
208. Fire Behavior and Use
210. Forest Pathology
211. Applied Ecology and Ecosystem Management
213. Forest Ecosystems
214. Ecology of Southern Appalachian Forests (intensive)
215. Environmental Physiology
216. Applied Population Ecology
218. Barrier Island Ecology
221. Forest Soils
230. Weather and Climate
231. Environmental Climatology
232. Microclimatology
234. Watershed Hydrology
236. Water Quality Management
237. Watershed Modeling and Management
251. Natural Resource Data Analysis
258. Forest Appraisal (intensive)
261. Remote Sensing for Resource Management
262. Forest Utilization (intensive)
263. Harvesting and Transportation Systems
264. Manufacturing Systems
267. Wildland and Wildlife Management
268. Resource Management and Business Practices (intensive)
269. Business Aspects of Natural Resources
270. Resource Economics and Policy
280. Economics in Forest Planning and Program Implementation (intensive)
283. Environmental Policy and Values
288. Forest Taxation (intensive)
299. Independent Projects
301. Forest Nutrition Management
302. Models in Forestry
305. Harvesting Effects on Productivity
306. Choices in Silviculture (intensive)
308. Tree Biology
309. Forest Regeneration
311. Ecological Toxicology
312. Wetlands Ecology
314. Integrated Case Studies in Toxicology
316. Case Studies in Environmental Management
318. Seminar in Ecotoxicology
322. Microbiology of Forest Soils
325. Ecologic Effects of Acidic Deposition
330. Environmental Monitoring and Instrumentation
331. Water Resource Systems
332. Air Quality Management and Modeling
335. Water Quality Modeling
350. Applied Regression Analysis
352. Matrix Methods for Resource Systems
355. Optimization Methods for Resource Management
357. Systems Ecology and Modeling
361. Forest Resource Management
363. International Trade and Forest Investment
366. Mathematical Modeling of Lake and Reservoir Water Quality (intensive)
367. Seminar in Forest Resource Management
370. Economics of Intensive Forestry (intensive)
372, 373. Advanced Natural Resource Economics
375. Timberland Investment Analysis (intensive)

381. Natural Resource Policy
383. Natural Resource Conflict Management (intensive)
384. Special Tax Problems for Industrial Timberland Owners (intensive)
385. Decision Theory and Risk Analysis
388. Seminar in Resource and Environmental Policy
389. Seminar in Forest and Conservation History
398. Program Area Seminar
399. Master's Project

Courses Outside of the School

The School of Forestry and Environmental Studies encourages students to take courses offered by other schools and departments at Duke, as well as the University of North Carolina-Chapel Hill and North Carolina State University. The following are representative of courses that are available and have been taken by students in the past few years to broaden their programs of study. For additional offerings and course descriptions, students should consult the graduate school bulletins of the three universities.

Business, Economics
Econometrics
Microeconomic Theory
Macroeconomic Analysis
Federal and Public Finance
Economic Growth Problems
International Monetary Theory
Industrial Governmental Relations
Financial Management
Industrial Organization
Financial Accounting

Botany, Zoology
Phycology
Biological Oceanography
Marine Ecology
Comparative Physiology
Physiological Plant Ecology
Plant Physiology
Community Ecology
Evolutionary Mechanisms
Tropical Biology

Environmental Science, Engineering
Aquatic Chemistry
Limnology and Water Pollution
Administration of Environmental Protection
Wastewater Treatment
Environmental Microbiology
Pollutant Transportation
Hazardous Wastes
Solid Waste Engineering

Forestry and Related Disciplines
Forest Genetics
Computer Cartography
Soil Morphology, Chemistry, and Microbiology
Forest Tree Improvement

Law
Land Use Planning
Judicial Administration Policy
International Business Transactions
Resource Law and Policy
Environmental Law
Wildlife Law

Mathematics, Statistics
Linear Models
Multivariate Statistics
Computer Numerical Analysis
Artificial Intelligence
Linear Algebra and Digital Computation
Bayesian Inference and Decision
Stochastic Methods

Planning
Planning Law
Planning Problems
Environmental Systems Analysis
Regional Land Planning
Water Resource Planning

Political Science, Public Policy
Microeconomics and Policy Making
Analytical Methods
Comparative International Development
Politics and Policy Processes

Toxicology
Mammalian Toxicology
Pharmacology and Toxicology
Biochemical Toxicology
Biochemistry
Neurotoxicology
Principles of Immunology

Appendix

Students Registered for the Master of Forestry Degree

Aaron, Kimberly Beth (B.S., Illinois Wesleyan University), Hawthorn Woods, Illinois

*Batts, Robert Waverly (B.S., Presbyterian College), Raleigh, North Carolina

Camp, Wade Foster (A.A., Brevard College; B.S., Purdue University), Savannah, Georgia

Cork, Travis Coleman, III (B.S., Clemson University), Conway, South Carolina

Cutko, Andrew Raymond (B.A., Williams College), Baltimore, Maryland

*Gilluly, David (B.S., Moravian College), Bangor, Pennsylvania

*Hamzah, Mohamed Zaki (B.S., Doane College), Trengganu, Malaysia

*Kagel, Christine Marie (A.B., Augustana College), Jackson, Wisconsin

Leonard, James Brian (B.S.F., University of New Hampshire), Northport, New York

Lester, Michael Bruce (A.A., University of Florida; B.S., Colorado State University), Breckenridge, Colorado

Lusk, Elizabeth Lee (B.A., Davidson College), Greensboro, North Carolina

*McCarthy, Patrick Wayne (B.A., Lycoming College), Chittenango, New York

McCormick, John Charles (B.S., Whitworth College), Spokane, Washington

McIntyre, Victor Loring (A.A., Brevard College; B.S., North Carolina State University), Durham, North Carolina

*Ritacco, Jeffrey L. (B.S., Rollins College), St. Paul, Minnesota

*Rockey, Marianne (B.S., Albright College), Gardners, Pennsylvania

*Schuetz, Kenneth John (B.S., Albright College), Bound Brook, New Jersey

*Sirkin, Robin Alena (B.S., West Virginia Wesleyan College), Miami, Florida

Smidt, Mathew Frank (Doane College), Blue Hill, Nebraska

*Wilson, Elizabeth Jeanne (B.S., Elizabethtown College), Cumberland, Maryland

*Woebkenberg, Andrea Mary (B.S., Albright College), Hatfield, Pennsylvania

*Wood, Jeffrey Ingraham (B.S., Miami University of Ohio), Carmel, Indiana

*Zweizig, Kurt Emil (B.S., Albright College), Wyndmoor, Pennsylvania

Students Registered for the Master of Environmental Management Degree

Albee, Mark Kohler (B.S., Bucknell University), Dunwoody, Georgia

Bierer, Lisa Ryn (B.S., University of Pittsburgh), Pittsburgh, Pennsylvania

*Bloss, Susan Lynne (B.A., The College of Wooster), Solon, Ohio

Bourne, James Winslow (B.A., Colby College), Potomac, Maryland

*Brucken, Elizabeth Ann (B.S., Albion College), Shaker Heights, Ohio

*Burrows, Mark Ross (B.A., Wake Forest University), Merritt Island, Florida

Callender, Edward Everett (B.A., James Madison University), Reston, Virginia

*Carson, Holly Alice (B.A.. Kenyon College), Sylvania, Ohio

Clark, Ruth Anne (B.S., Davidson College), Summit, New Jersey

*Coffey, Steven William (A.B., Ripon College), Arkansas City, Kansas

*Combs, Karen Ann (B.A., Kenyon College), Cincinnati, Ohio

Cook, Allison Gray (B.S., University of California-Davis), Bellevue, Washington

Copeland, Susan Renee (B.A., University of Tennessee), Oak Ridge, Tennessee

Cusumano, Cynthia Ann (A.B., Vassar College), Commack, New York

Dei, George Jerry Sefa (B.A., University of Ghana; M.A., McMaster University; Ph.D., University of Toronto), Koforidda, Ghana

*Di Mauro, Desiree (B.S., The College of William and Mary), Springfield, Virginia

*Donato, Timothy Francis (B.S., Christopher Newport College), Williamsburg, Virginia

*Donnelly, Michael Lawrence (Xavier University of Ohio), Cincinnati, Ohio

Douglass, Nancy Jeanne (B.S., University of Vermont), Islamorada, Florida

Duffin, Julie Michaela (B.A., Pitzer College), El Cerrito, California

*Dunn, Sandra Elaine (B.A., Hiram College), Durham, North Carolina

Eichner, Melissa Jane (B.A., University of Maryland-Baltimore County), Ellicott City, Maryland

Emmott, Robert George (B.S., Virginia Polytechnic Institute and State University), Culpepper, Virginia

*Flickinger, David Scott (B.A., Western Maryland College), Edgewater, Maryland

Ford, Noreen (B.S., University of Santa Clara), Menlo Park, California

Gelber, Beth Mara (B.S., University of Michigan), Bronx, New York

*Gollnick, Krista Ann (B.A., Whitman College), Walla Walla, Washington

Green, Beverly Ann (B.S., Huxley College), Maryville, Tennessee

*Granger, William Jeffrey (Alfred University), Hornell, New York

Guevara, Lorraine Eva (B.S., SUNY College of Environmental Science and Forestry), Amherst, New York

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*Attended an undergraduate institution participating in the Cooperative College Program.

*Hansen, Laura Ann (B.S., Iowa State University), Bettendorf, Iowa
Henning, Loren Elliott (B.A., Carleton College; M.S., Northwestern University), Chicago, Illinois
*Hitzig, Robert Alan (B.A., Miami University of Ohio), Shaker Heights, Ohio
Hodges, Luther Hartwell (B.A., Williams College), Linville, North Carolina
Hohenstein, William Gerald (B.S., Cook College-Rutgers University), Philadelphia, Pennsylvania
Huff, Lisa Carol (B.S., University of Tennessee), Aiken, South Carolina
Jackson, Laura E. (A.B., Bryn Mawr College), Raleigh, North Carolina
*Jacobs, Thomas Dale (A.B., Duke University), Shawnee Mission, Kansas
James, Joel Edward (B.A., Winona State University), Burlington, North Carolina
*Jenkins, Eric Wayne (B.A., Indiana University of Pennsylvania), Indiana, Pennsylvania
Johnson, Elizabeth Ames (B.S., Davidson College), Severna Park, Maryland
*Keen, David Edward (B.S., Presbyterian College) Atlanta, Georgia
*Kidd, Tara Jane (B.S., Eastern Illinois University), Barrinton, Illinois
Klem, Robin Marie (A.S., B.S., Ferrum College), Rocky Mount, Virginia
Knotts, Karen Sue (B.A., Hood College), Frederick, Maryland
Knouse, Kimberly Christel (B.S., Bucknell University), Ambler, Pennsylvania
*Lopazanski, Michael Joseph (B.A., Gettysburg College), Perth Amboy, New Jersey
*Mann, Linda Sue (B.S., St. Andrews Presbyterian College), Concord, North Carolina
Markewitz, Daniel (B.S., University of Michigan), Roslyn, New York
*Mason, Victoria Anne (B.A., Lawrence University), Appleton, Wisconsin
*McCarthy, Shane Patrick (B.S., Juniata College), McGraw, New York
McConnell, Clifton Waite (A.B., Washington University), Mascutah, Illinois
*McKelvey, John Ridgway (B.S., University of the South), Nashville, Tennessee
McLean, Joan Straub (B.S., University of North Carolina-Chapel Hill), Chapel Hill, North Carolina
McLinn, Christopher John (B.A., St. Olaf College), International Falls, Minnesota
*Mistele, Thomas Michael (B.S., The College of William and Mary), Hollins, Virginia
*Moyer, Jonathan Andrew (Bridgewater College), Hatfield, Pennsylvania
Noell, Louise Turpin (B.S., North Carolina State University), Raleigh, North Carolina
*Norton, Richard Kenvin (B.A., The College of Wooster), Elyria, Ohio
O'Loughlin, JoAnne (B.S., Villanova University), Needham, Massachusetts
Omdal, Daniel William (B.S, Houghton College), Huntingdon Valley, Pennsylvania
Pannebaker, Reneé E. (B.A., Kenyon College), Middletown, Pennsylvania
*Patel, Sangita Harshadri (B.S., The College of Wooster), Nairobi, Kenya
Pepper, Joan Diane (B.A., Taylor University), Brookville, Indiana
Paulsen, Carl Hendrick (B.A., Middlebury College), Plainfield, Vermont
*Peters, Jennifer Joy (B.A., Wittenburg University), Novelty, Ohio
*Peterson, Paul Eric (B.S., The College of William and Mary), Forest Grove, Oregon
Pfefferle, Mark Clifford (B.A., Simon Fraser University), Pine Falls, Manitoba, Canada
*Pierce, Richard Brayton, Jr. (B.S., The College of William and Mary), Alexandria, Virginia
*Pistrang, Mark Jay (B.A., Whitman College), Seattle, Washington
Plé, Jean-Pierre (B.A., University of Wisconsin), Queens Village, New York
*Potje, Anne Barbara (Augustana College), Crystal Lake, Illinois
Quentin, David Halsey (B.A., State University of New York-Oswego), South Salem, New York
*Reinhardt, Debra R. (B.A., Knox College), Sycamore, Illinois
*Rhodes, Lynne Marie (Allegheny College), Gaithersburg, Maryland
*Rogers, Smith Manning (B.S., Duke University), Port Tobacco, Maryland
Runkel, Robert Lee (B.S., Mankato State University), Harmony, Minnesota
*Sabol, Jeffrey Robert (B.S., The College of William and Mary), Leesburg, Virginia
*Scoville, Michael David (B.S., Allegheny College), Honeoye, New York
*Seadale, Scott Edward (B.A., Gettysburg College), Ft. Lauderdale, Florida
Smith, Cherri Lee (B.A., Bucknell University), Hillsborough, North Carolina
Spellman, Caroline Barbara (B.Sc., McGill University), Glen Falls, New York
Stifel, Ann Este (B.S., Trinity College), Glouchester, Virginia
*Stout, David James (B.S., Albright College), Brunswick, New Jersey
Subramanian, Romesh Ramsunder (B.S., Loyola College-Madras), Anna Nagar, Madras, India
Suit, Lorelei Ann (B.A., Goucher College), Bethlehem, Pennsylvania
*Takahashi, Leslie (A.B., University of North Carolina-Chapel Hill; Duke University), Chapel Hill, North
    Carolina
*Thomas, Richard Neil (B.S., Warren Wilson College), Swannanoa, North Carolina
*Timmer, Eva Joan (B.S., Calvin College), Grand Rapids, Michigan
Timmerman, Timothy Lloyd (B.S., George Washington University), Amherst, Massachusetts
*Tippett, JoAnne (B.A., The College of Wooster), Pittsburgh, Pennsylvania
Tyler, Marian Winifred (B.S., University of Missouri-Columbia), Columbia, Missouri
Van Dyken, Deborah Anne (B.S., Shephard College), Shephardson, West Virginia
Vogel, Ann Hildreth (B.S., Dickinson College), Los Angeles, California
Volosin, Joseph Steven (B.A., University of California-Santa Barbara), Somerville, Massachusetts

*Votteler, Todd Haydn (B.S., University of the South), Dallas, Texas
Walter, Adam Brewster (B.S., Tufts University), Concord, Massachusetts
Watts, Jean Guy (B.S., B.A., Unversity of Kentucky), Louisville, Kentucky
Wenning, Richard J. (B.A., University of Denver), Holden, Massachusetts
Werntz, James Herbert, III (B.A., Grinnell College), Charlotte, North Carolina
Wynne, Thomas Joseph (B.S., Maryville College), Franklin, Tennessee
Zaleski, Rosemary Theresa (B.A., Cook College-Rutgers University), Fords, New Jersey

Students in the Department of Forestry and Environmental Studies of the Graduate School

In Residence
Andrianarivo, Jonah A. (D.E.A., University of Madagascar), Antananarivo, Madagascar
Bates, Louis Thomas (B.A., Davidson College), Arlington, Virginia
Bevington, Stephen Raymond (B.S., University of Wisconsin; M.E.M., Duke University), Chicago, Illinois
Bridgham, Scott D. (B.A., M.S., University of Maine; M.S., University of Minnesota), Augusta, Maine
Burke, Ann-Marie (B.S., Boston College), Hopkinton, Massachusetts
Chalfant, Sharla Elizabeth (B.S., University of Arkansas), Durham, North Carolina
Chang, Hsing-Yi (B.S., National Taiwan University), Taipei, Taiwan
Chen, Qiuyun (B.S., Xiamen University), Hangzhou, Zhejiang, People's Republic of China
Conklin, Paul Sheldon (B.A., Carleton College), Minneapolis, Minnesota
Dong, Quan (Beijing Normal University, Beijing Medical College), Beijing, People's Republic of China
Faulkner, Stephen P. (B.S., M.S., Louisiana State University), Baton Rouge, Louisiana
Fendik, Edward Andrew (B.S., M.S., University of San Francisco), Sacramento, California
Frost, Don Joaquin (B.S., Carleton College), Arlington, Virginia
Habig, R. Clifford (B.A., University of Southern Maine; M.S., University of Georgia), Chebeague Island, Maine
Hendry, Karen Mack (A.B., Duke University), Durham, North Carolina
Hines, Deborah Ann (B.A., University of Montana; M.F., Duke University), Durham, North Carolina
Ho, Menghi (B.S., National Taiwan University), Taipei, Taiwan
Huang, Ce (M.S., Shanghai Institute of Plant Physiology), Shanghai, People's Republic of China
Li, Anan (B.S., M.S., Beijing Forestry College), Beijing, People's Republic of China
Mallin, Michael Andrew (B.S., Ohio University; M.S., University of Florida), Raleigh, North Carolina
Marty, Rebecca Suzanne (B.A., Carleton College), Mason City, Iowa
Marty, Timothy David (B.S., M.S., University of Missouri), Columbia, Missouri
Mercer, Daniel Evan (B.S., Stanford University; M.S., University of Michigan), Denton, Texas
Mihaich, Ellen Mather (B.A., Wellesley College; M.S., Duke University), Elmer, New Jersey
Mitchell, James E. (B.S., University of California-Irvine; M.S., University of Michigan), Orange, California
Murray, Brian Charles (B.S., University of Delaware), Alexandria, Virginia
Mussio, Donna Francesca (A.B., Duke University), Rumson, New Jersey
Powell, Douglas Smith (B.S., University of Michigan; M.S.F., West Virginia University), Springfield, Pennsylvania
Pozniak, Tadeusz Janusz (M.S., University of Agriculture, Szczecin, Poland), New York, New York
Raich, James William (B.S., Michigan State University; M.S., University of Florida), Gainesville, Florida
Rosenbaum, Debra Jean (B.A., University of Delaware), Chestertown, Maryland
Sasser, Cari Lynn (A.B., Cornell University), Hamilton, Ohio
Sines, Rae Ann (B.S., University of Iowa), Pittsburgh, Pennsylvania
Smith, Mark Griffin (A.B., Harvard University), Durham, North Carolina
Stow, Craig Alan (B.S., Cornell University; M.S., Louisiana State University), Baton Rouge, Louisiana
Swallow, Stephen K. (B.S., Cornell University), Ithaca, New York
Tanaka, Yesuhisha (B.A.G., M.A.G., University of Tokyo), Saitama, Japan
Valentine, David William (B.A., Wittenberg University; M.S., Duke University), Albuquerque, New Mexico
Warren-Hicks, William James (B.S., University of Houston; M.S., University of Texas), Durham, North Carolina
Williams, Harvey Timothy (B.S., University of North Carolina at Chapel Hill), Durham, North Carolina
Ye, Yazome Henri (B.S., Burkina-Faso University; M.S., Auburn University), Ouagadougaa, Burkina-Faso

In Absentia
Bell, Randy Lee (B.S., Marshall University), Belle, West Virginia
Jacobson, Susan Kay (B.A., Brown University; M.S., University of Florida), Dover, Massachusetts
Krutilla, Kerry Maca (B.A., Grinnell College), Washington, D.C.
Lesh, Steven August (B.S.Ch.E., University of Cincinnati; M.S.E.E., M.A.C.T., University of North Carolina-Chapel Hill), Chapel Hill, North Carolina
Pye, John Matthew (B.A., Swarthmore College; M.A., University of North Carolina-Chapel Hill), Durham, North Carolina
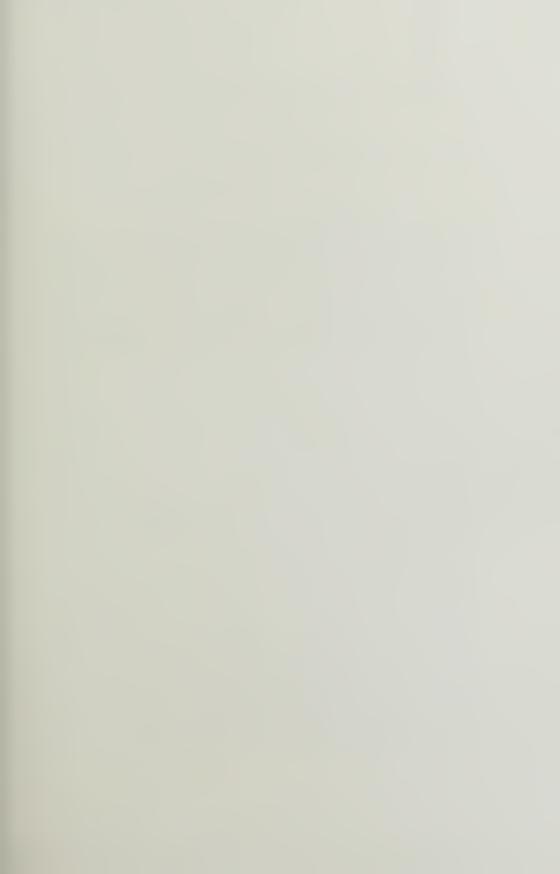Rieff, Susan Karol (B.S., Texas Christian University; M.P.A., University of Texas-Austin), Washington, D.C.

Woodbridge, William Craig (B.A., Dartmouth College), Topsfield, Massachusetts

On Leave of Absence
Di Mauro, Thomas Michael (B.S., M.S., Massachusetts Institute of Technology), Rockfall, Connecticut
Wick, John Glen (B.A., University of Notre Dame; M.L.A., University of Virginia), Baton Rouge, Louisiana
Young, David Lawrence (B.S., Lenoir-Rhyne College; M.F., Duke University), Durham, North Carolina

DUKE UNIVERSITY

CRS◆

OFFICE OF THE UNIVERSITY ARCHITECT
DEPARTMENT OF PHYSICAL PLANNING
JAMES A. WARD — DIRECTOR

0 200 400

JANUARY 1978

WEST CAMPUS

MEDICAL CENTER

CENTRAL CAMPUS

EAST CAMPUS

WEST CAMPUS 77xx

MEDICAL CENTER 76xx

CENTRAL CAMPUS 70xx and 71xx

EAST CAMPUS 72xx

NOT SHOWN ON MAP

Marine Laboratory

bulletin of
Duke University 1987

Marine Laboratory

The information in this bulletin applies to the calendar year 1987 and is accurate and current, to the extent possible, as of August 1986. The University reserves the right to change programs of study, academic requirements, teaching staff, the calendar, and other matters described herein without prior notice, in accordance with established procedures.

Contents

University Administration

Administration of the Marine Laboratory

Academic Staff

*Summer only.
†Spring and fall only.

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Support Staff

Cynthia K. Baldwin, *Manager, Personnel and Auxiliaries*
Olive C. Godette, *Housekeeping Supervisor*
Claudia O. Davis, *Housekeeper Senior*
Eunice T. Godette, *Housekeeper*
Mildred E. Tyre, *Housekeeper*
Bettie E. Tyson, *Housekeeper*
L. Thomas Morton, *Head Cook*
Sylvester Murray, *Assistant Head Cook*

Norris A. Hill, *Manager, Physical Plant*
Clifton W. Davis, *Maintenance Foreman*
Ellen D. Jones, *Staff Assistant*
James G. Chadwick, *Groundskeeper*
Donald Gagnon, *Electrician*
Horace R. Holland, *Mechanic*
Vance G. Mason, *Carpenter Senior*
James L. Willis, *Captain, R/V First Mate*

Dianne R. Gagnon, *Business Manager*
Patricia M. Nolin, *Staff Specialist*
Norma S. Troutman, *Staff Specialist*
Sophia D. Turnage, *Staff Specialist*
Margaret J. Forward, *Artist Illustrator*
Lucretia Garrigan, *Secretary, Development*
Scott D. Taylor, *Photographer*

Mamre M. Wilson, *Staff Assistant*
Helen E. Nearing, *Word Processor*
Mildred Bennett, *Junior Switchboard Operator*
Susan H. Kenney, *Senior Switchboard Operator*

Joseph S. Ramus, *Assistant Director for Academic Programs*
William D. Hunnings, *Electronics Technician Senior*
Michele M. Shivers, *Academic Recruiter*
Lilian I. Lorenzsonn-Willis, *Staff Specialist*
Jean S. Williams, *Library Associate*

Joseph Bonaventura and Celia Bonaventura, *Codirectors of the Marine Biomedical Center*
Belinda K. Beckwith, *Staff Assistant*

Joseph F. Ustach, *Executive Officer, Duke/University of North Carolina Oceanographic Consortium*
Eric B. Nelson, *Marine Superintendent, Duke/University of North Carolina Oceanographic Consortium*
George A. Newton, *Assistant Marine Superintendent, Duke/University of North Carolina Oceanographic Consortium*
Dorothy T. Johnson, *Staff Assistant*
Sue Book, *Secretary*
Timothy W. Boynton, *Electronics Technician Senior*
Robert D. Currier, *Electronics Technician*
David L. Bunting, *Draftsman Senior*
Woody Sutherland, *Computer Technician*
Jacqueline Ramus, *Data Technician Senior*

Richard C. Ogus, *Master, R/V Cape Hatteras*
Dale H. Murphy, *Chief Mate, R/V Cape Hatteras*
Larry N. Morris, *Second Mate, R/V Cape Hatteras*
Jay Venger, *Bosun, R/V Cape Hatteras*
Frank Krusz, Jr., *Ordinary Seaman, R/V Cape Hatteras*
Curtis A. Oden, *Deck Engineer, R/V Cape Hatteras*
Orville G. Weeks, *Chief Engineer, R/V Cape Hatteras*
Mitchell Dixon, *First Assistant Engineer, R/V Cape Hatteras*
Robert Lipscomb, *Steward/Cook, R/V Cape Hatteras*
Byron Boyer, *Cook/Messman, R/V Cape Hatteras*

General Information

The Beaufort Setting

The Duke University Marine Laboratory is situated on fifteen acres of Pivers Island, within the Outer Banks of North Carolina, and adjacent to the historic town of Beaufort. Beaufort itself is the third oldest town in the state and is surrounded by fishing and agricultural communities. Cape Lookout National Seashore Park and the Rachel Carson Estuarine Sanctuary are located within easy boating distance of the Marine Laboratory. From the Marine Laboratory, as well as from the Beaufort waterfront and its boardwalk, one can often see feral horses grazing, see egrets or pelicans flying by, or just observe the beautiful natural scenery in its entirety.

The Natural Resources for Study and Research

The area's system of barrier islands, sounds, and estuaries is well-known for its rich flora and fauna, and diverse habitats, including rivers, creeks, mud flats, unspoiled sand beaches, dunes, marshes, peat bogs, cypress swamps, bird islands, and coastal forests, making the area an excellent haven for both nature lovers and those interested in the pursuit of marine science. The area lies within the range of both the temperate and tropical species of biota. The edge of the Gulf Stream oscillates between twenty and thirty miles offshore, with occasional reefs in between. A great variety of phytoplankton, seaweeds, seagrasses, and marsh-grasses may be found in the area. Common animals include the blue crab, squid, shrimps, snails, clams, ctenophores, jellyfish, hydroids, sponges, polychaetes, sea urchins, starfish, brittle stars, sand dollars, skimmers, terns, gulls, herons, sea turtles, porpoises, and many species of fish. All provide ample opportunity for study and research and are readily accessible from the Marine Laboratory on foot, by car, or by boat.

The Marine Laboratory

This rich abundance of marine flora and fauna attracted Dr. A. S. Pearse and colleagues from Duke University to Pivers Island, which was subsequently selected as a location for a marine laboratory. Through the efforts of Dr. Pearse, the land was acquired for the Duke University Marine Laboratory, and by 1938 the first buildings were erected. Originally, the laboratory served only as a summer training and research facility.

The Marine Laboratory has experienced considerable growth since 1938, and today operates year-round to provide training and research opportunities to more than 1,500 persons annually, including undergraduate and graduate students enrolled in the laboratory's academic programs, visiting student groups who utilize the laboratory's facilities, as well as scientists who come from North America and abroad to conduct their own research.

The Marine Laboratory is an interdepartmental training and research facility of Duke University, and as such operates under the policies, procedures, and regulations of the University. Each resident faculty member is affiliated with one or more department of the University. The resident faculty represent the fields of biochemistry, ecology, developmental biology, geology, oceanography, physiology, and systematics.

Pivers Island is only 150 yards across the channel from Beaufort, with a bridge leading to U.S. Highway 70, making the island readily accessible by automobile. Other transportation to the laboratory consists of bus service to Beaufort (via New Bern, North Carolina) and airline service to regional airports (New Bern, Kinston, or Jacksonville).

The modern physical plant consists of twenty-three buildings, including four dormitories, a large dining hall, one residence, boathouse, storehouse for ship's gear, classroom laboratories, six research buildings, and a maintenance complex.

On the Marine Laboratory campus there are recreational facilities for fishing, swimming, rowing, sailing, shuffleboard, volleyball, and croquet. There are also ample opportunities for recreation in and around Beaufort. The Beaufort area is well-known for its moderate climate, tempered by the Gulf Stream.

The laboratory's year-round seminar/lecture series features many distinguished scientific speakers from across the nation and abroad who help to acquaint both students and fellow researchers with the latest findings in their respective research areas, or present other lectures of a more general nature. Many of the lectures are open to the public as well as to personnel from surrounding marine facilities.

The Beaufort-Morehead City area provides location for five other facilities which collectively are one of the higher concentrations of marine scientists in the nation. These are the University of North Carolina, Institute of Marine Sciences; North Carolina State University, Seafood Laboratory; State of North Carolina, Marine Resources Center; State of North Carolina, Division of Marine Fisheries; and the National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Beaufort Laboratory. This concentration of marine scientists provides a critical mass for the pursuit of science and education.

THE DUKE/UNIVERSITY OF NORTH CAROLINA OCEANOGRAPHIC CONSORTIUM

The Oceanographic Consortium operates a 135-foot oceanographic research vessel, the R/V *Cape Hatteras*. Designed as a coastal zone research vessel, the ship operates both on the continental shelf and in the deep sea in the western North Atlantic, concentrating in the region between Nova Scotia and the Caribbean. The ship is a member of the academic research fleet supported by the National Science Foundation for the purpose of providing oceanographic research opportunities to investigators. R/V *Cape Hatteras* is used for training at sea by the five universities that make up the Oceanographic Consortium (Duke, North Carolina State, UNC-Chapel Hill, UNC-Wilmington, and East Carolina). The consortium also manages the acquisition and maintenance of oceanographic instrumentation used aboard R/V *Cape Hatteras*, and promotes annual meetings of marine science staff and graduate students from member institutions. These meetings are held at the Duke University Marine Laboratory.

THE MARINE BIOMEDICAL CENTER

The National Institute of Environmental Health Sciences (NIEHS) provides support to the Duke University Marine Biomedical Center with the objective of promoting research in the marine sciences relevant to problems of environmental health. The research goals of the Duke University Marine Biomedical Center are to gain an understanding of the mechanisms involved in the adaptation of man and other organisms to an environment that is both hostile and continually changing. Emphasis is on the biochemical and biological impact of metallic pollutants.

Studies at the center concern: (1) the effects of chemical pollutants on respiratory proteins and electron transport proteins; (2) the effects of metal and nonmetal pollutants on larval development of various invertebrates; (3) pollutant toxicology using blood as a model organ; (4) behavioral aspects of pollution of estuarine and marine systems; (5) the role of metal and nonmetal pollutants in processes associated with animal, plant, and artificial membrane systems; and (6) effects of heavy metals on ion transport phenomena and cellular membrane potentials. Feasibility studies are conducted to explore the advantages of various experimental approaches and to encourage innovative research.
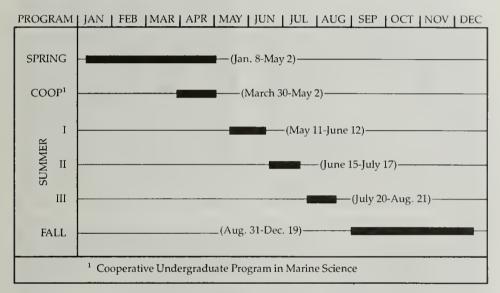
The Beaufort Experience

The Marine Laboratory is an academic community and the self-sufficient nature of its residential life serves well those who come here to study or to conduct research. The academic programs are limited to fifty students per regular academic semester or summer term (spring, summer, or fall), making for small group learning. Although recreational opportunities are ample, the distractions are limited, allowing both student and researcher to become totally involved in the pursuit of marine science. Both students and researchers alike find that the Marine Laboratory has an invitingly open, friendly, and relaxed atmosphere which draws many back year after year. This community feeling, as well as the potential for total immersion, has become part of what has been termed the Beaufort experience.

1987
Duke University Marine Laboratory
Calendar

PROGRAM	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC

SPRING ▬▬▬▬▬▬ (Jan. 8-May 2) —————————————————

COOP[1] ▬▬ (March 30-May 2) —————————————————

SUMMER
I —————— ▬▬ (May 11-June 12) —————————————
II ——————————— ▬▬ (June 15-July 17) —————————
III ————————————————— ▬▬ (July 20-Aug. 21) ——————

FALL ————————— (Aug. 31-Dec. 19) ———————— ▬▬▬▬▬▬

[1] Cooperative Undergraduate Program in Marine Science

The academic programs and curricula listed herein may be subject to change.

Spring Semester—Undergraduate Marine Sciences Program

8 January-2 May 1987

A full study list ordinarily is four (4) course credits. The curriculum consists of the courses below.

Biological Oceanography. (Botany 114L or Zoology 114L.) Physical, chemical, and biological processes of the oceans, emphasizing special adaptations for life in the sea and factors controlling distribution and abundance of organisms. Laboratory emphasis. Prerequisite: introductory biology. One course. *Ramus*

Physiology of Marine Animals. (Zoology 150L.) Environmental factors, biological rhythms, and behavioral adaptations in the comparative physiology of marine animals. Prerequisites: introductory biology and chemistry. One course. *Forward*

Geological Oceanography. (Geology 205S.) The geology of ocean basins, including origin, bottom physiography, sediment distribution, and sedimentary

processes. Field observations; sampling procedures. Not open to students who have completed Geology 206S. One course. *Johnson*

Physical Oceanography. (Geology 203.) Physical processes in the oceans: the physical properties of seawater, the dynamics of currents, waves and tides, and the transmission of light and sound in the sea. Prerequisite: Physics 41 or 51. Half course. *Johnson*

Beach and Island Geological Processes. (Geology 196S.) Processes affecting evolution of beaches and barrier islands with emphasis on the effect of construction. Half course. *Pilkey*

Global Biogeochemical Cycles. (Botany 296S or Zoology 296S.) This seminar will consider the biogeochemical cycling of carbon, nitrogen and sulfur, paying particular attention to how human activities have modified these cycles. Half course. *Barber*

Experimental Ecology of the Marine Intertidal Zone. (Zoology 296S.) Reading and discussion of papers published since about 1960. Half course. *Sutherland*

Independent Study. (Botany 192, Geology 192, Geology 195, Zoology 192 or Physiology 210.) For seniors and juniors with consent of the appropriate Director of Undergraduate Studies and the supervising instructor. One course. *Staff*

COOPERATIVE UNDERGRADUATE PROGRAM IN THE MARINE SCIENCES
30 March-2 May 1987

During the late spring, the Duke University Marine Laboratory offers an intensive five-week program on the marine environment to students from institutions which have no marine laboratory facilities.

Lectures in the program cover the physical, chemical, geological, and biological aspects of the marine environment with emphasis on the ecology of marine organisms. Numerous field trips are made to estuarine and near-shore habitats which involve environmental measurements, identification of plants and animals collected, and discussion with emphasis on morphological, physiological, and ecological adaptations to the particular habitat. Students read original research papers, give oral reports on relevant topics, and submit written reports on laboratory and field work.

First Summer Term
11 May-12 June 1987

Marine Biology. (Biology 10L.) Physical and chemical characteristics of marine ecosystems and the functional adaptations of marine organisms to these systems. Lectures, field trips, and laboratories. For students not majoring in a natural science. One course (4 s.h.*). *Kirby-Smith*

Biological Oceanography. (Botany 114L or Zoology 114L.) Physical, chemical, and biological processes of the oceans, emphasizing special adaptations for life in the sea and factors controlling distribution and abundance of organisms. Laboratory emphasis. Prerequisite: introductory biology. One and one-half courses (6 s.h.). *Barber*

Physiology of Marine Animals. (Zoology 150L or Zoology 250L.) Environmental factors, biological rhythms, and behavioral adaptations in the comparative physiology of marine animals. Prerequisites: introductory biology and chemistry. One course or 4 graduate units (4 s.h.). *Forward*

Semester Hour(s) = s.h.

Marine Invertebrate Zoology. (Zoology 176L.) Structure, functions, and development of invertebrates collected from estuarine and marine habitats. Not open to students who have had Zoology 274L. Prerequisite: introductory biology. One and one-half courses (6 s.h.). *Bookhout*

Independent Study. (Botany 191 or Zoology 191.) For senior and junior majors with permission of the appropriate director of undergraduate studies and the supervising instructor. Course credit to be arranged. *Staff*

Research. (Botany 359.) Individual investigation in the various fields of botany. Credit to be arranged. (For graduate students only.) *Staff*

Research. (Zoology 353.) To be carried on under the direction of the appropriate staff members. Hours and credit to be arranged. (For graduate students only.) *Staff*

Second Summer Term

15 June-17 July 1987

Marine Ecology. (Zoology 203L.) Application of ecological theory to marine systems. Mathematical properties of population growth and species interactions; field and laboratory projects with computer-assisted analysis of data. Practice in scientific writing. Readings from current scientific publications. Prerequisites: introductory biology or invertebrate zoology, and calculus; knowledge of statistics recommended. One and one-half courses or 6 graduate units (6 s.h.). *Hay (visiting summer faculty)*

Primary Productivity in the Seas. (Botany 215L or Zoology 215L.) The biological flux of carbon in the coastal and open seas involving phytoplankton, seaweeds, seagrasses, and marshgrasses. The contributions of these primary producers to food chain processes and global atmospheric-sedimentary cycles, as well as the ecological consequences of variations in photosynthetic mechanisms. Prerequisites: introductory biology and introductory chemistry. One course or 4 graduate units (4 s.h.). *Barber and Ramus*

Barrier Island Ecology. (Botany 218L or Forestry and Environmental Studies 218.) Adaptation of plants to barrier island migration and other physical characteristics of the coastal environment. Major emphasis on management of barrier beaches from Maine to Texas and the impact of human interference with natural processes. Field studies. Prerequisite: course in general ecology. One and one-half courses or 6 graduate units (6 s.h.). *Leatherman (visiting summer faculty)*

Continental Margin Sedimentation. (Geology 295S.) Sediment composition and distribution on the continental margin, with emphasis on North Carolina barrier island/lagoon, shelf and slope environments. The course includes field work and laboratory analyses of sediments as well as readings and discussion of the current literature. Prerequisite: Geology 205S or Geology 206S or consent of instructor. One and one-half courses or 6 graduate units (6 s.h.). *Johnson and Wells (visiting summer faculty)*

Independent Study. (Botany 192 or Zoology 192.) For senior and junior majors with permission of the appropriate director of undergraduate studies and the supervising instructor. Course credit to be arranged. *Staff*

Research. (Botany 360.) Individual investigation in the various fields of botany. Credit to be arranged. (For graduate students only.) *Staff*

Research. (Zoology 354.) To be carried on under the direction of the appropriate staff members. Hours and credit to be arranged. (For graduate students only.) *Staff*

Third Summer Term

20 July-21 August 1987

Marine Biology. (Biology 10L.) Physical and chemical characteristics of marine ecosystems and the functional adaptations of marine organisms to these systems. Lectures, field trips, and laboratories. For students not majoring in a natural science. One course (4 s.h.). *Staff*

Marine Policy. (Public Policy Studies 195S.) Formal study of policy and policymaking regulating the exploitation of the marine environment. History of specific marine-related organizations, legislation, and issues are traced and their effects on local, regional, national, and international arenas. Topics explored through use of theoretical and methodological perspectives, including political science, sociology, and economics. Lectures, including seminar presentations by visiting marine policymakers and policy analysts. Major emphasis is national in scope; some examples from North Carolina and the Mid- and South Atlantic areas. One course (3 s.h.). *Orbach (visiting summer faculty)*

Benthic Marine Algae. (Botany 219L.) Morphology, reproduction, life histories, systematics, and natural history of seaweeds. Lectures, laboratories, and field work in ocean and estuaries. Prerequisite: introductory biology; plant diversity recommended. One course or 4 graduate units (4 s.h.). *Schneider (visiting summer faculty)*

Marine Invertebrate Zoology. (Zoology 274L.) Structures, functions, and habits of invertebrate animals under natural and experimental conditions. Field trips included. Not open to undergraduate students who have had Zoology 176L except by consent of Director of Undergraduate Studies. Prerequisite: introductory biology. One and one-half courses or 6 graduate units (6 s.h.). *Staff*

Invertebrate Developmental Biology. (Zoology 278L.) Gametogenesis, fertilization, and development of invertebrates, with emphasis on experimental studies of prelarval stages. Prerequisite: consent of instructor. One and one-half courses or 6 graduate units (6 s.h.). *McClay and visiting staff*

Independent Study. (Botany 191 or Zoology 191.) For senior and junior majors with permission of the appropriate Director of Undergraduate Studies and the supervising instructor. Course credit to be arranged. *Staff*

Research. (Botany 359.) Individual investigation in the various fields of botany. Credit to be arranged. (For graduate students only.) *Staff*

Research. (Zoology 353.) To be carried on under the direction of the appropriate staff members. Hours and credit to be arranged. (For graduate students only.) *Staff*

Fall Semester—Undergraduate Marine Sciences Program

31 August—19 December 1987

A full study list ordinarily is four (4) course credits. The curriculum consists of the courses listed below.

Marine Animal Diversity. (Zoology 76L.) Form, function and evolution of invertebrate metazoans excluding arachnids, insects and myriapods. Lectures and laboratories using live marine invertebrates to relate structures to the processes of sensory perception, feeding, digestion, respiration, locomotion, reproduction and development. Adaptations of invertebrates to their natural environment will be the subject of field trips to estuarine and coastal habitats. One course. *Kirby-Smith*

Marine Sediments. (Geology 109S or Geology 209S*.) Sedimentary processes in nearshore, shelf and deep-sea environments. Emphasis on field methods and laboratory analyses. (*Geology 209S: additional requirement of term paper.) One course. *Johnson*

Organization of Marine Communities. (Zoology 169L.) Dynamics of marine communities in the context of current ecological theory. Life history strategies, competition, predation, diversity, and stability; detailed considerations of benthic and pelagic communities. Students may not receive credit for both Zoology 103L and 169L. Prerequisites: introductory biology and mathematics. One course. *Sutherland*

Light in the Sea. (Botany 195S.) Properties of light in the sea and the biological consequences; orientation, bioluminescence, biological rhythms, primary production, and sensing devices. Half course. *Ramus*

Beach and Island Geological Processes. (Geology 196S.) Processes affecting evolution of beaches and barrier islands with emphasis on the effect of construction. Half course. *Pilkey*

Physical Oceanography. (Geology 203.) Physical processes in the oceans: the physical properties of seawater, the dynamics of currents, waves and tides, and the transmission of light and sound in the sea. Prerequisite: Physics 41 or 51. Half course. *Johnson*

Global Biogeochemical Cycles. (Botany 295S or Zoology 295S.) This seminar will consider the biogeochemical cycling of carbon, nitrogen and sulfur, paying particular attention to how human activities have modified these cycles. Half course. *Barber*

Marine Animal Navigation. (Zoology 295S.) Orientation to visual, chemical, mechanical, and magnetic cues. To examine aspects of the cues used for navigation, behavior involved, functional significance, and experimental design. Half course. *Forward*

Independent Study. (Botany 191, Geology 191, Geology 195, Zoology 191 or Physiology 210.) For seniors and juniors with consent of the appropriate Director of Undergraduate Studies and the supervising instructor. One course. *Staff*

Graduate Program

Graduate students from any and all academic disciplines are encouraged to take professional training at the Marine Laboratory. The program operates year-round, providing course work in the marine sciences, an active seminar program, and facilities supporting dissertation research. Resident graduate students represent the Departments of Biochemistry, Botany, Foresty and Environmental Studies, Geology, Physiology, and Zoology. Ordinarily, dissertation advisers are resident as well, although this need not be the case. The Marine Laboratory has available a small number of full-time instructional assistantships and some number of summer assistantships for graduate student support. In addition, tuition credits obtained from fellowship support may be applied to courses given both at the Marine Laboratory and the Durham campus, regular semesters and summer terms. Students are admitted to degree programs in regular academic departments, not the Marine Laboratory. Generally, degree requirements, excepting dissertation research, are met on the Durham campus, then students take residence at the Marine Laboratory for dissertation research.

Marine Sciences Education Consortium (MSEC)

The Marine Sciences Education Consortium (MSEC) was developed to provide a formal curriculum in the marine sciences, including supervised research, to member institutions. Such institutions are liberal arts colleges or universities attended by students who are preparing for careers in the marine sciences or who have a strong liberal arts interest in the oceans but for whom no specialized programs in the marine sciences are available. Duke University has developed the specialized coastal physical plant, vessels, equipment, library, and faculty necessary to implement such programs. MSEC students have access to the spring and fall semester programs in marine sciences as well as the summer program here at the Duke Marine Laboratory, including room/board facilities. Currently, member institutions include Denison University, Furman University, Gettysburg College, Hood College, Juniata College, North Carolina State University, Oberlin College, Presbyterian College, Trinity College, and Wittenberg University.

Members join upon invitation and mutual agreement. Inquiries from interested institutions are welcome and requests to join the MSEC will be considered. Such inquiries should be addressed to the Assistant Director for Academic Programs, Duke University Marine Laboratory, Beaufort, North Carolina 28516.

Visiting Scholar Programs

The exchange of knowledge is kept lively by several programs which bring distinguished scientists/educators to the Marine Laboratory. The Visiting Scholar Program brings lecturers for a period of several days on a monthly basis year-round. The Cocos Foundation brings visitors for longer periods of time, usually five weeks and only during the summers. The scholars, while in residence, lecture to the community at large as well as enrich specific research groups.

Requirements and Procedures

Spring and Fall Semester—Undergraduate Marine Sciences Programs. During the spring and fall semesters interdisciplinary programs in marine sciences provide an opportunity for undergraduate students to live and study at the Marine Laboratory. The programs are open to qualified junior and senior students. In the case of Duke students, participation in both the spring and fall semesters is possible only with the consent of their departmental adviser.

Duke students can obtain the appropriate application form from the back of this bulletin, the Director of Undergraduate Studies in their major department, or by writing to the Marine Laboratory. Duke students should submit the completed application. Non-Duke students should submit the appropriate application form (contained toward the back of this bulletin), one letter of recommendation from academic faculty, and a current transcript of academic work. All completed applications and supporting credentials, if required, (from all applicants) should be received prior to the preceding 31 October (for spring semester 1987) and the preceding 25 March (for fall semester 1987) by the Admissions Office of the Marine Laboratory. (Applications received after these dates will be considered on a space-available basis.) Students will be notified of the action of the Admissions Committee shortly after each deadline.

Summer Terms. Introductory level courses (numbered below 100) offered during the summer at the laboratory are open to all qualified college students; advanced level courses (numbered 100 to 199) are intended for undergraduate students from the sophomore to the senior level; senior-graduate level courses (numbered from 200 to 299) are intended for advanced undergraduates and graduate students (juniors and well-qualified sophomores may enroll in these courses with special permission). Undergraduates may not enroll in 300-level courses.

Students apply for all *undergraduate* and *graduate courses* and for *graduate graded research* by submitting the Summer Session application found at the back of this bulletin.

The application and current transcripts (in the case of those who are applying to courses numbered 100 or above) should be submitted by all applicants to the Admissions Office of the Duke University Marine Laboratory as early as possible to allow for adequate processing time and to assure a space in the desired course(s). Late applicants will be considered if space permits. All applicants will be notified by mail as promptly as possible after a decision has been reached concerning their application. Upon acceptance, payment of required deposit(s) is essential to reserve space in a course as well as room and board accommodations.

Students who have had adequate preparation and approval of their major professor may request space for independent or thesis research. Students register for *ungraded graduate research* and *residence only* on *Graduate School course cards* (available from the appropriate director of graduate studies and from the Marine Laboratory Admissions Office and *to be returned to the Graduate School, 127 Allen Building*).

Summer Credit. The summer session term credit does not mean degree credit at Duke University unless the student has been admitted as a degree candidate by one of the colleges or schools of the University. Other students will be categorized as nondegree (unclassified) students for the summer only. A student taking a course for credit is expected to do all the work required and to take the final examination, and will receive a grade.

Summer Minimum Enrollment. Some courses are offered subject to minimum enrollments. In withdrawing a course not having adequate enrollment, every effort will be made to place the student in an alternate course which has been listed by the student as a second choice.

Summer Maximum Program Load. The maximum load for one term of the summer session at the Marine Laboratory is a one and one-half course (or 6 graduate unit) program (semester hour equivalents are listed under the course descriptions). A greater load may be possible only with the approval of the student's Dean or the appropriate director of graduate studies. Non-Duke students must obtain approval from the director of the summer session.

Financial Information

Figures quoted in this section are projections in some cases and may be subject to change without prior notice.

SPRING AND FALL SEMESTER—UNDERGRADUATE MARINE SCIENCES PROGRAMS

Tuition. Tuition for the spring semester will be $4,590. Information regarding tuition for the fall semester will be available at a later date. (See also section on payment of tuition and fees.)

Health Fee. Students are required to pay $101 for the spring semester. Information regarding the health fee for the fall semester will be available at a later date.

Student Activity Fee. The student activity fee for the spring semester will be $49.35. Information regarding the student activity fee for the fall semester will be available at a later date.

Room and Board. The total room and board fee for the spring semester will be $2,100. Information regarding the room and board fee for the fall semester will be available at a later date.

All dormitory occupants must supply their own linens, blankets, and towels, but pillows will be furnished. If a key is desired, a key deposit of $10 (per semester) will be charged each person occupying a room. This deposit will be refunded at time of departure and return of key.

Full board provides for three meals a day, Monday through Saturday, and breakfast and dinner on Sunday. No credit will be allowed for meals that are missed.

Estimated Semester Costs. Estimated costs for the spring semester will be: tuition—$4,590; health fee—$101; student activity fee—$49.35; room and board —$2,100. Estimated costs for the fall semester will be available at a later date. Books, if required by the instructor, will be available at registration.

Payment of Tuition and Fees. The Office of the Bursar (Duke University, Durham campus) will issue invoices to registered students for tuition, fees, and other charges approximately four to six weeks prior to the beginning of classes each semester. The *total amount due* on the invoice is payable by the invoice late payment date which is normally one week prior to the beginning of classes. A student is required to pay all invoices as presented. If full payment is not received, a late payment charge as described below will be assessed on the next invoice and certain restrictions will be applied. Failure to receive an invoice does not warrant exemption from the payment of tuition and fees nor from the penalties and restrictions. (Duke University students on other tuition payment plans—see the current *Bulletin of Duke University: Undergraduate Instruction*.) Nonregistered students will be required to make payment at the time of registration. Payments should be sent to the address indicated on the invoice and not to the Duke Marine Laboratory.

Late Payment Charge. If the *total amount due* on an invoice is not received by the invoice late payment date, the next invoice will reflect a penalty charge of 1 and 1/4 percent per month assessed on the past due balance regardless of the number of days past due. The *past due balance* is defined as the previous balance less any payments and credits received on or before the due date and also any student loan memo credits, related to the previous balance, which appear on the invoice.

SUMMER TERMS

Tuition. The following are tuition charges for summer registration.

1. Undergraduate students: $798 for each nonlaboratory or 3 semester hour (s.h.) course; $1,064 for each undergraduate laboratory or 4 s.h. course; $532 for each half-course (2 s.h.); and $1,596 for each one and one-half course (6 units) program (6 s.h.) offered at the Duke University Marine Laboratory.
2. Graduate students: $266 per unit (s.h.). For an undergraduate course, the tuition rate indicated in section 1 above is applicable.

Auditing Fees.

1. With permission of the instructor and the director, students registered for a full program (6 s.h.) may audit courses. No extra charge is made.
2. Students carrying less than a full program (6 s.h.) may be granted permission by the instructor and the director to audit a course, but must pay half the University fee for the course.

Health Fee. Students are required to pay an estimated $29 per term.

Room and Board. Total charges for room and board are estimated at $695 per term. More definitive information will be available at a later date.

Air-conditioned, as well as a few non-air-conditioned, dormitory rooms are available. (Upon acceptance in a course, students will be sent an acceptance and reservation form. Reservation for housing and board should be made on this form and the form promptly returned to the Marine Laboratory along with the room and board reservation deposit, if the student elects to utilize room and board.)

Occupants must supply their own linens, blankets, and towels, but pillows will be furnished.

Full board provides for three meals a day, Monday through Saturday, and breakfast and dinner on Sunday. There will be no credit allowed for missed meals.

Deposits.

1. Course Deposit. Upon acceptance in a course, a nonrefundable deposit of $50 (per course) is required to ensure a reservation in that course. If the student properly registers for the course and attends, the deposit will be credited to tuition.
2. Room and Board Deposit. A $50 deposit (per term) is required to ensure a reservation for room and board. If the student properly registers, the deposit will be credited to the room and board charge. The deposit is refundable if a student who has previously made a room and board reservation properly withdraws from a course prior to the beginning of the term. *The deposit is nonrefundable if a student who has previously made a room and board reservation at the Marine Laboratory subsequently decides not to utilize the room and board facilities (although he or she still plans to attend the course) and does not notify the Marine Laboratory at least two weeks prior to the beginning of the term.*
3. Key Deposit. If a key is desired, a key deposit of $10 per term will be charged each person occupying a dormitory room. This deposit will be refunded at time of departure and return of the key.

Estimated Term Costs. Estimated costs for each of the summer terms will be: tuition—(see tuition section); student health fee—$29; room and board—about $695. Books, if required by the instructor, will be available at registration.

Payment of Tuition and Fees. Duke University Marine Laboratory does not mail statements for summer term tuition and fees. All tuition and fees must be paid to the Accounting Office (Duke University Marine Laboratory, Beaufort,

North Carolina 28516) at least three full working days prior to the first day of class (the first day of each term—see Duke University Marine Laboratory calendar). Checks should be made payable to Duke University Marine Laboratory and may be mailed to the above address. *Failure to pay tuition and fees by the end of the drop/add period (the first three days of classes in any term) will result in administrative withdrawal of the student.* Withdrawn students may not attend class or subsequently be registered for the term. Students who are unable to meet these deadlines should consult with the Accounting Office prior to the deadline.

Late Payment Charge. Students who fail to pay all tuition and fees before three full working days prior to the first day of class (the first day of each term) will pay an extra $25 fee.

TRANSCRIPTS

Requests for transcripts of academic records should be directed to the Associate Registar, Office of the Registrar, 103 Allen Building, Duke University, Durham, North Carolina 27706. Ten days should be allowed for processing. A fee of $1, payable in advance, is charged for each copy. Such requests should not be directed to the Marine Laboratory.

REFUNDS

Spring and Fall. In the case of withdrawal from the University, students or their parents may elect to have tuition refunded or carried forward as a credit for later study according to the following schedule:

Withdrawal	*Refund*
Before classes begin	Full amount
During first or second week	80 percent
During third, fourth, or fifth week	60 percent
During sixth week	20 percent
After sixth week	None

Tuition charges paid from grants or loans will be restored to those funds on the same pro rata basis and will not be refunded or carried forward. In addition to tuition, the schedule also applies to other Marine Laboratory fees. In the event of death, a full tuition and fees refund will be granted.

Summer Terms—Withdrawal Charge and Refund of Tuition and Fees. *Students who will not be attending a summer term or course* for which they have been officially accepted must drop the course(s) prior to the first day of class, even if they have not paid tuition and fees. *Failure to drop the course(s) will result in administrative withdrawal* at the end of the first three days of the term and billing of the student for twenty percent of the tuition plus the health fee. If tuition and fees have been paid, the following refund policies apply:

1. When applications for withdrawal or drops from a course or term are received by the Admissions Office of the Duke University Marine Laboratory before the first class day of a given term, full tuition and fees will be refunded.
2. When applications for withdrawal or drops from a course or term are received by the Admissions Office of the Duke University Marine Laboratory during the first three class days of a given term, 80 percent of the tuition and the room and board fee will be refunded. The health fee will not be refunded. There will be no charge for drop/adds which result in no change in tuition.
3. When applications for withdrawal or drops from a course or term are received by the Admissions Office of the Duke University Marine Laboratory after the third class day, there will be no refund of tuition and fees.

CHECK CASHING

The banks in the Beaufort-Morehead City area have indicated that they will not cash personal checks for students unless they are guaranteed. Therefore, it is recommended that students who come to the laboratory bring with them sufficient travelers' checks, money orders, certified checks (which the banks will cash), or cash to cover personal expenses. The Marine Laboratory will accept personal checks to pay course fees.

Financial Assistance

Bookhout Scholarship. The Bookhout Scholarship provides financial assistance to juniors, seniors, or beginning graduate students with a professional interest in the natural sciences. Aid is provided solely for summer term courses taken at the Duke University Marine Laboratory. Recipients will be chosen for academic excellence, the scope of preparation, and experience. Applicants will be required to submit the same credentials as stated for the Duke University Marine Laboratory Summer Tuition Scholarships (see below). The deadline will also be the same.

Deborah Susan Steer Memorial Scholarship in Marine-Life Sciences. Each year the income from the fund will be used to provide financial assistance to promising Duke undergraduates who wish to study marine life-sciences at the Duke University Marine Laboratory. Priority will be given to students in the summer session. Application must be made and supporting credentials received by the Admissions Office of the Marine Laboratory no later than 30 March 1987. Additional information is available from the Admissions Office of the Marine Laboratory upon request.

The Wade Family Fund. The income from this fund will be used to support undergraduate or graduate student participants in the academic programs of Duke University Marine Laboratory. Awards will be made at the discretion of the Director of the Marine Laboratory.

Rachel Carson Graduate Fellowship. Students enrolled in any graduate degree program of Duke University will be eligible to apply. The recipient would be expected to develop research related to some aspect of the Rachel Carson Estuarine Sanctuary and must be resident at Beaufort.

Duke University Marine Laboratory Summer Tuition Scholarships. Several summer tuition scholarships will be awarded on a competitive basis. Awards require that the student live on campus, i.e., take room and board at Duke University Marine Laboratory. In addition to the summer application which has already been submitted by the student, the following credentials will be required to complete the scholarship application: (1) academic transcript(s), if not already submitted as part of the summer application, (2) a statement of purpose for taking the particular course and, (3) one letter of recommendation from academic faculty. Intent to apply for a scholarship should be made known in writing (no separate application blank is utilized for scholarship purposes) and received by the Admissions Office of the Marine Laboratory, along with all supporting credentials, no later than 30 March 1987. Announcements of scholarship award will be made by mail shortly thereafter.

Instructional Assistantships. Several graduate student instructional assistantships will be available during the academic year, including summer. Students registered in a graduate program in any department in the sciences at Duke University may apply. Recipients must be in residence at Beaufort during the period of their appointment and also conduct, or plan to conduct, their research at the Duke University Marine Laboratory in Beaufort.

Applications must be received by the Assistant Director for Academic Programs on, or before, 27 February 1987. Applicants will be judged on the basis of need, qualifications for the courses in which they will assist, and previous teaching and graduate experience. A student may receive a maximum of three years' support under the program.

For further information, write the Assistant Director for Academic Programs, Duke University Marine Laboratory, Beaufort, North Carolina 28516.

Financial Aid. Financial aid is available to Duke undergraduate students for each summer session. Interested students can obtain specific details and an application through the Financial Aid Office (2106 Campus Drive, Durham campus) in March of each year.

Resources for Study and Research

Research Staff and Their Programs

Dr. Richard T. Barber. Biological Oceanography.

The variability of tropical productivity and trophic structure of ocean ecosystems is being studied in the Pacific between South America and Southeast Asia. This work also involves long-term study of the coastal ocean involving shore stations in Peru, Ecuador, and the Galapagos Islands and oceanographic work in the western Pacific Ocean.

Barber, R. T.; Kogelschatz, J. E.; and Chavez, F. P. 1985. Origin of biological anomalies during the 1982/83 El Nino. *Calif. Coop. Oceanic Fish. Invest. Report* 26:65-71.

Barber, R.; Kogelschatz, J.; Chavez, F.; and Thayer, V. 1985. Nutrient and chlorophyll distribution in the equatorial Pacific Ocean. In *El Nino Atlas 1982-1983*, eds. A. Leetma and J. Witte, chapter 14, pp. 149-155. Atlanta: U.S. Government Printing Office.

Barber, R. T. and Chavez, F. P. 1986. Ocean variability in relation to living resources during the 1982/83 El Nino. *Nature* 319:279-285.

Drs. Joseph Bonaventura and Celia Bonaventura. Physiological and Biochemical Adaptations of Organisms to the Marine Environment and Marine Biotechnology.

Marine organisms are found in environments characterized by great diversity in temperature, pH, salinity, oxygen availability, etc. Through biochemical studies the structural and functional diversity of these organisms and their environments is being shown to be paralleled by diversity at the molecular level. The respiratory proteins of marine organisms are being studied in order to increase the understanding of molecular adaptations and the mechanisms which give rise to functional flexibility. Investigations include measurements of the kinetics and equilibria of ligand binding to hemoglobins, hemocyanins, and cytochrome c oxidase with emphasis on the reactivity of these proteins as regulated by metabolic effectors. The subunit interactions involved in assembly of giant hemocyanin molecules are also under investigation. These studies are complemented by work in the Protein Engineering and Technology Laboratory where properties of chemically modified, crosslinked, and immobilized forms of biologically active molecules are characterized.

Bickar, D.; Bonaventura, J.; Bonaventura, C.; Auer, H.; and Wilson, M. 1984. Paradoxical effects of methylmercury on the kinetics of cytochrome c oxidase. *Biochemistry* 23:680-684.

Bickar, D.; Lehninger, A.; Brunori, M.; Bonaventura, J.; and Bonaventura, C. 1985. Functional equivalence of monomeric (shark) and dimeric (bovine) cytochrome *c* oxidase. *J. Inorg. Biochem.* 23:365-372.

Johnson, B. A.; Bonaventura, C.; and Bonaventura, J. 1984. Allosteric modulation of *Callinectes sapidus* hemocyanin by binding of L-lactate. *Biochemistry* 23:872-878.

Sugihara, J.; Imamura, T.; Nagafuchi, S.; Bonaventura, J.; Bonaventura, C.; and Cashon, R. 1985. Hemoglobin Rahere, a human hemoglobin variant with amino acid substitution at the 2,3-diphosphoglycerate binding site. Functional consequences of the alteration and effects of bezafibrate on the oxygen bindings. *J. Clin. Invest.* 76:1169-1173.

Dr. C. G. Bookhout. Larval Ecology and Larval Development of Invertebrates.

This laboratory investigates the effects of pollutants, such as insecticides and drilling fluids, on the complete development of mud-crabs and blue crabs. Also, a study of the development of the family of crabs to which the blue crab belongs is being conducted.

Bookhout, C. G.; Costlow, J. D.; and Monroe, R. 1980. Kepone* effects on larval development of mud-crab and blue crab. *Water Air Soil Pollut.* 13:57-77.

Bookhout, C. G.; Monroe, R. J.; Forward, R. B., Jr.; and Costlow, J. D., Jr. 1984. Effects of soluble fractions of drilling fluids on development of crabs, *Rhithropanopeus harrisii* and *Callinectes sapidus. Water Air Soil Pollut.* 21:183-197.

Bookhout, C. G.; Monroe, R. J.; Forward, R. B., Jr.; and Costlow, J. D., Jr. 1984. Effects of hexavalent chromium on development of crabs, *Rhithropanopeus harrisii* and *Callinectes sapidus. Water Air Soil Pollut.* 21:199-216.

Dr. Marius Brouwer. Biochemistry of Respiratory and Metal-binding Proteins.

(1) Basic studies on the mechanism of oxygen binding by respiratory proteins and by organo-metallic complexes. (2) Biochemical mechanisms of trace metal toxicity in marine invertebrates and fish. (3) Characterization of structure and function of trace metal-binding proteins in marine fish and shellfish.

Brouwer, M.; Bonaventura, C.; and Bonaventura, J. 1983. Metal ion interactions with *Limulus polyphemus* and *Callinectes sapidus* hemocyanin: Stoichiometry and structural and functional consequences of calcium (II), cadmium (II), zinc (II) and mercury binding. *Biochemistry* 22:4713-4723.

Brouwer, M.; Brouwer-Hoexum, T.; and Engel, D. W. 1984. Cadmium accumulation by the blue crab, *Callinectes sapidus:* Involvement of hemocyanin and characterization of cadmium-binding proteins. *Mar. Environ. Res.* 14:71-88.

Brouwer, M., and Brouwer-Hoexum, T. 1985. Mechanism of Cu(II) and Hg(II) induced loss of red blood cell deformability. *Fed. Proc.* 44:2620.

Brouwer, M.; Whaling, P.; and Engel, D. 1986. Copper-metallothioneins in the American lobster, *Homarus americanus:* Potential role as Cu(I) donors to apohemocyanin. *Environ. Health Perspect.* 65:93-100.

Dr. Robert Cashon. Effect of Metabolic Intermediates on Hemoglobin Function.

Being investigated are the effects of metabolites on the oxygen binding properties of normal and abnormal human hemoglobins and on fish hemoglobins.

Cashon, R. 1981. The Malate Dehydrogenase Isozymes and Allozymes of *Fundulus heteroclitus.* The Johns Hopkins University Ph.D. dissertation.

Focesi, A.; Cashon, R.; Bonaventura, C.; and Bonaventura, J. 1983. Allosteric interactions of nicotinamide nucleotides and EDTA with human hemoglobin. *Fed. Proc.* 42:2030.

Dr. John D. Costlow. Crustacean Development.

Much of the research in developmental biology deals with the culture of invertebrate larvae under controlled conditions in the laboratory, from hatching until the juvenile stages are reached. The availability of numerous larvae of known species, age, and stage of development has led to studies on the extent to which environmental factors within the marine environment affect rates of development, survival, and morphological abnormalities. In addition to studying the effects of natural environmental factors, research is under way to determine the effects of pollutants on larval development of marine crustacea. The developmental biology program also includes studies on the physiology of crustacean larvae and the factors involved in regulation of molting, rate of development, and metamorphosis during larval development.

A second major area of research interest involves the hormonal and physiological factors regulating barnacle development, settling, and metamorphosis. Present studies include the identification of naturally occurring substances in other marine organisms which inhibit or prevent the settlement of acorn barnacles and the mechanisms of detection by the larvae of these compounds.

Costlow, J. D. 1982. Impact of toxic organics on the coastal environment. In *Impact of Man on the Coastal Environment*, ed. T. W. Duke, EPA-600/8-82-021, pp. 86-95.

Freeman, J., and Costlow, J. D. 1983. Endocrine control of spine epidermis resorption during metamorphosis in crab larvae. *Roux's Arch. Dev. Biol.* 192:362-365.

Costlow, J. D., and Tipper, R. C., eds. 1984. Marine biodeterioration: An interdisciplinary study. In *Proceedings of the Symposium on Marine Biodeterioration*, Uniformed Services, University of Health Sciences, 20-23 April 1981, 408 pp. Copyright® 1984 U.S. Naval Institute Press, Annapolis, Maryland.

Dr. Richard B. Forward, Jr. Physiological Ecology.

This laboratory investigates the behavior and physiology of estuarine and coastal zooplankton. This includes the photobehavior, photophysiology, biological rhythms, diurnal vertical migration, and horizontal migration of crustacean larvae. Past students have worked with crustaceans and chaetognaths on the effects of temperature, salinity, and feeding on phototaxis and geotaxis, salinity perception, polarized light perception, and field studies of horizontal and vertical distributions as related to environmental factors.

Forward, R. B., Jr. 1985. Behavioral responses of larvae of the crab *Rhithropanopeus harrisii* (Brachyura: Xanthidae) during diel vertial migration. *Mar. Biol.* 90:9-18.

Forward, R. B., Jr., and Lohmann, K. J. 1983. Control of egg hatching in the crab *Rhithropanopeus harrisii* (Gould). *Biol. Bull.* 165:154-166.

Forward, R. B., Jr.; Cronin, T. W.; and Stearns, D. E. 1984. Control of diel vertical migration: Photoresponses of a larval crustacean. *Limnol. Oceanogr.* 29:146-154.

Dr. John Gutknecht. Membrane Physiology.

This laboratory studies the mechanisms of solute and water transport through phospholipid bilayer membranes which are used as models of biological membranes. Some of the specific questions sought include the following: (1) How do heavy metals, e.g., Hg and Cd, permeate biological membranes? (2) What is the mechanism of action of thiocyanate and other drugs on the gastric mucosa? (3) How do water and small nonelectrolytes traverse biological membranes? (4) What is the mechanism of proton and hydroxyl ion transport through lipid bilayer membranes? (5) What are the rate limiting steps in weak acid/base transport through membranes?

Gutknecht, J. 1981. Inorganic mercury transport through lipid bilayer membranes. *J. Membr. Biol.* 61:61-66.

Gutknecht, J. 1984. Proton/hydroxide conductance through lipid bilayer membranes. *J. Membr. Biol.* 82:105-112.

Gutknecht, J., and Walter, A. 1982. SCN⁻ and HSCN transport through lipid bilayer membranes: A model for SCN⁻ inhibition of gastric acid secretion. *Biochim. Biophys. Acta* 685:233-240.

Dr. Irving Hooper. Biologically Active Marine Products and New Types of Anti-Fouling Surfaces.

We have isolated and characterized a series of bioactive compounds from marine organisms. These compounds inhibit barnacle settlement in nanogram amounts. We are applying immobilization chemistry to the development of unique biochemically modified surfaces and studying the effect of such surfaces on the fouling process.

Standing, J. D.; Hooper, I. R.; and Costlow, J. D. 1984. Inhibition and induction of barnacle settlement by natural products present in octocorals. *J. Chem. Ecol.* 10:823.

Rittschof, D.; Hooper, I. R.; and Costlow, J. D. 1985. Inhibition of barnacle settlement and behavior by natural products from whip corals, *L. virgulata*. *J. Chem. Ecol.* 11:551-563.

Keifer, P. A.; Rinehart, K. L.; and Hooper, I. R. 1986. Renillafoulins, antifouling diterpenes from the sea pansy *Renilla reniformis. J. Org. Chem.* (In press.)

Dr. Thomas C. Johnson. Geological Oceanography.

Research involves deep-sea sedimentation studies in the western North Atlantic and the application of oceanographic techniques to the study of sedimentation in large lakes. Present emphasis is upon Pleistocene paleocurrent studies and high-resolution seismic reflection profiling, side-scan SONAR, and sediment core analyses in Lakes Turkana and Malawi, East Africa.

Johnson, T. C.; Lynch, E. M.; and Showers, W. F. 1985. Holocene flushing of the deep western North Atlantic. *EOS* 66:937

Halfman, J. D.; Johnson, T. C.; Strelitz, R. A.; and Rosendahl, B. R. 1985. Periodicities in sediment lamination thickness in Lake Turkana, Kenya. *EOS* 66:816.

Dr. Bruce E. Kenney. Algal Ecological Physiology.

Physiological ecology of photosynthesis by marine algae, specifically the influence of environmental conditions on photosynthetic production, is my primary area of interest. Understanding time scales of environmental variabiltiy is essential to determining the influence of such variations on photosynthetic performance. Evaluation of fixed carbon partitioning under varying environmental conditions is a current goal. Computer-aided data acquisition devices are being developed for rapid laboratory and field evaluation of several aspects of primary production.

Kenney, B. E., and Ramus, J. 1983. Short-term variations in seaweed photosynthetic quotients. *EOS Abstr.* 64(52):1042.

Litaker, W.; Duke, C. S.; Ramus, J.; and Kenney, B. 1983. High frequency variability in nutrients and chlorophyll in a southeastern estuary. *EOS Abstr.* 64(52):1042.

Dr. William W. Kirby-Smith. Marine Ecology.

Funded research projects include: (1) a study of the fates and effects of pesticides and herbicides in estuaries; (2) the response of invertebrates, fish and birds to open marsh water management for mosquito control; and (3) aerial photographic mapping of the North Carolina estuarine sanctuaries. In addition, I work on problems associated with the feeding and growth of suspension feeders in relation to quantity and quality of food.

Kirby-Smith, W. W., and Ustach, J. 1986. Resistance to hurricane damage of an epifaunal community on the continental shelf off North Carolina. *Estuarine Coastal Shelf Sci.* (In press.)

Ustach, J.; Barber, R. T.; and Kirby-Smith, W. 1986. Effect of watershed modification on a small coastal plain estuary. *Proc. Estuarine Res. Fed.* (In press.)

Dr. Cynthia H. Pilskaln. Marine Sedimentology.

Current research focuses on: (1) particulate flux and pelagic deposition of shoal-water carbonates in the Bahamas; (2) the role of zooplankton fecal aggregate transport to biogeochemical particle fluxes in the Black Sea; (3) the contribution of fecal aggregates to the particulate organic carbon content of Nova Scotian Rise sediments; and (4) mechanisms of sedimentation in Lake Malawi, East Africa. Emphasis is on data obtained from seismic reflection profiles, sediment trap samples, sediment cores, suspended particle profiles and current meter measurements.

Pilskaln, C. H.; Neumann, A. C.; and Bane, J. M. 1985. Periplatform carbonate flux in Northwest Providence Channel, Bahamas: Results from a 2-month sediment trap experiment. *EOS* 66:1293.

Pilskaln, C. H., and Honjo, S. 1986. The fecal pellet fraction of biogeochemical particle fluxes to the deep-sea. *Biogeochem. Cycles (In press.)*

Dr. J. Ramus. Algal Ecological Physiology.

We study physical forcing of primary productivity in a coastal plains estuary characterized by high flushing rates and variable nutrient inputs. To do so requires time-intensive sampling on the estuary—including selected hydrology, water chemistry, meteorology, and productivity parameters. Ultimately, the research seeks a match between species specific physiological response and the temporal frequency of nutrient availability, the phasing of the organism with its environment.

Biotechnological research includes extracellular polysaccharides produced by marine microphotoautotrophs. Two aspects are under investigation: (1) environmental regulation of carbon partitioning, i.e., the diversion of newly fixed carbon from growth (new photosynthetic machinery) to disposable heteropolysaccharides (viscoelastic biopolymers), and (2) drag reducing properties of the biopolymers in pipe flow.

A third area of investigation is photoacclimation in seaweeds. Of specific interest are macromolecular changes in the photosynthetic apparatus, the dynamic range of change and the effect of change on growth rate.

Ramus, J. 1986. Rhodophyte unicells: Biopolymer, physiology and production. *Beih. Nova Hedwigia* (In press.)

Ramus, J., and van der Meer, J. P. 1983. A physiological test of the theory of complementary chromatic adaptation. I. Color mutants of a red seaweed. *J. Phycol.* 19:86-91.

Litaker, R. W.; Duke, C. S.; Kenney, B. E.; and Ramus, J. 1986. The role of short-term variability in natural phytoplankton abundances. *Nature* (In press.)

Dr. Daniel Rittschof. Chemical Ecology.

(1) Basic studies of the chemical nature and functions of substances indicating prey and nonprey resource location. (2) Contact chemoreception, chemical induction,and inhibition of barnacle settlement. (3) Isolation and purification of native bioactive molecules. (4) Nontoxic repellants.

Rittschof, D. and Bonaventura, J. 1986. Molecular cues in marine systems. *J. Chem. Ecol.* 12:1011-1021.

Rittschof, D.; Hooper, I. R.; and Costlow, J. D. 1985. Inhibition of barnacle settlement and behavior by natural products from whip corals, *L. virgulata.* *J. Chem. Ecol.* 11:551-563

Rittschof, D.; Forward, R. B., Jr.; and Mott, D. D. 1985. Larval release in the crab *Rhithropanopeus harrisii* (Gould): Chemical cues from hatching eggs. *Chem. Sens.* 10:567-577.

Dr. Richard B. Searles. Seaweed Systematics.

Biology of seaweeds with emphasis on systematics, ecology, and biogeography of tropical algae from North Carolina and the Caribbean.

Searles, R. B. 1984. Seaweed biogeography of the mid-Atlantic coast of the United States. *Helgoländer Meeresunter.* 38:259-271.

Searles, R. B. 1983. Vegetative and reproductive morphology of *Dudresnaya georgiana* sp. nov. (Rhodophyta, Dumontiaceae). *Phycologia* 22:309-316.

Peckol, P., and Searles, R. B. 1983. Effects of seasonality and disturbance on population development in a Carolina continental shelf community. *Bull. Mar. Sci.* 33(1):67-86.

Dr. J. Bolling Sullivan. Comparative Protein Biochemistry.

The primary emphasis in the biochemical studies involves research on the structure, function, and evolution of protein molecules. Proteins, especially those involved in the transport of molecular oxygen (hemoglobin, hemocyanin, chlorocruorin, and hemerythrin), are being isolated and their structural and functional properties elucidated. These studies are intended to illustrate how protein molecules function, as well as how they have evolved. Studies of protein polymorphisms are intended to illustrate gene flow among populations and offer insights into the adaptive strategies of marine organisms.

Sullivan, B.; Pennell, L.; Hutchison, B.; and Hutchings, R. 1983. Genetics and evolution of the hemocyanin multigene. I. Genetic variability in *Uca pugilator* from Beaufort, N.C. *Comp. Biochem. Physiol.* 76:615-618.

Sullivan, B.; Miller, K.; Singleton, K.; Scheer, A. G.; and Williams, A. B. 1984. Electrophoretic analyses of hemocyanins from four species of mud crabs, genus *Panopeus*, with observations on the ecology of *P. obesus. Fish. Bull.* (In press.)

Dr. John Sutherland. Marine Ecology.

The research attempts to identify and understand the processes which result in the temporal and spatial patterns in species abundance in intertidal and subtidal, epibenthic communities. Changes in the adult populations are followed with point sampling and photographic techniques. The approach is experimental to the extent that species are removed or excluded from the community to assess their importance in community structure and function. This work was initiated with estuarine animal populations near Beaufort. Comparable work is now being done on the plant and animal populations in the rocky substrates of southern Chile and the Pacific coast of Central America.

Sutherland, J. P. 1981. The fouling community at Beaufort, North Carolina: A study in stability. *Am. Nat.* 118:499-519.

Moreno, C. A., and Sutherland, J. P. 1982. Physical and biological processes in a *Macrocystis pyrifera* community near Valdivia, Chile. *Oecologia* 55:1-6.

Dr. Joseph Ustach. Marsh Ecology.

Structure and functioning of wetlands, especially salt marshes, within the estuarine system. Major areas of interest are: primary production; decomposition; detritus formation and utilization; habitat utilization; microbial-meiofaunal interactions.

Ustach, J. F. 1982. Algae, bacteria and detritus as foods for the harpacticoid copepod, *Heteropsyllus pseudonunni* Coull and Palmer. *J. Exp. Mar. Biol. Ecol.* 64:203-214.

Heinle, D. R.; Flemer, D. A.; and Ustach, J. F. 1976. Contribution of tidal

marshlands to mid-Atlantic estuarine food chains. In *Estuarine Processes,* ed. M. Wiley, pp. 309-320. New York: Academic Press.

Research Facilities

Visiting investigators may obtain research space throughout the year. Each research laboratory building is air-conditioned and equipped with running seawater through a PVC system. There are tanks, water tables, aquaria, autoclaves, ovens, and outdoor continuous-flow growth facilities. In addition to commonly used laboratory equipment, the following are available: refrigerated centrifuges, fluorometers, spectrophotometers, balances, pH meters, hoods, liquid scintillation counter, and constant temperature equipment. There is a complete sedimentological research laboratory that is equipped for state-of-the-art chemical and size analyses. The Marine Laboratory also maintains darkrooms, a well-equipped workshop, a stock room, and a purchasing department.

As a result of funds provided by the National Science Foundation, the following new research equipment and systems are available to visiting investigators at Duke Marine Laboratory as well as to resident research personnel: water purification system, spectrophotometer, camera, recorder and accessories, spectrofluorometers, power supply, M-Drive, CRT screens, and a printer for the Compupro computer, a respirometer as well as accessory items for the existing underwater spectroradiometer.

In addition, the National Science Foundation has funded a number of general facility improvements such as renovations to the R/V *First Mate*, renovations to the seawater system, and updating the autoanalyzer to state-of-the-art equipment.

Funding made available by the Office of Naval Research has provided for a flow injection nutrient analyzer, IBM AT computer, and accessory items for the existing underwater spectroradiometer.

I. E. Gray Library-Auditorium. Located in the building are the 1,917 square feet auditorium, with stage, a library, the librarian's office, two seminar rooms, a receiving room, a kitchenette, and two closed carrels. The auditorium has a seating capacity of approximately 300 and is suitable for lectures, seminars, symposia, and small regional or national meetings. Inquiries concerning use of auditorium or seminar room space should be addressed to Personnel and Auxiliaries, Duke University Marine Laboratory, Beaufort, North Carolina 28516.

The building houses the Pearse Memorial Library which contains about 53,000 catalogued reference books and journals, 155 current journals, and 23,000 reprints. There are also expedition reports in oceanography, a microfilm library of graduate student theses based on research at the laboratory, and a microfilm reader. Other materials may be obtained by special delivery system from the Perkins Library on the Durham campus or through the interlibrary loan service with other libraries in the United States.

Reference Collections. A reference collection of approximately 4,500 lots representing more than 1,800 species of animals and macroalgae from estuaries and the continental shelf of North Carolina is available to students and research personnel. A library of monographs, identification guides, and checklists of marine organisms is maintained. Books and specimens may be checked out for teaching and research purposes. The museum serves as a clearing house for information on natural history, providing visitors with access to information on identification and availability of North Carolina marine organisms.

Computing Facilities. The Marine Laboratory operates a Compupro System 8/16 computer for use by staff, students, and visiting investigators. The computer has 1 MB of memory and is operated under the MC-DOS operating system. The BASIC, FORTRAN, and Pascal programming languages are available, as well as

application programs for word processing, statistical analysis, data base management, and graphics. A 21Mb hard disk drive and two eight-inch floppy disk drives are used for data storage. There are a variety of video terminals, graphics terminals, printers and plotters.

R/V Cape Hatteras. The Duke/University of North Carolina Oceanographic Consortium operates a 135-foot research vessel, the R/V *Cape Hatteras*. Although designed as a coastal zone research vessel, the ship operates both on the continental shelf and in the deep sea in the western North Atlantic, concentrating in the region between Nova Scotia on the north, the Caribbean on the south, and Bermuda to the east. The ship is a member of the academic research fleet supported by the National Science Foundation for the purpose of providing oceanographic research opportunities to investigators. Inquiries concerning use of the research vessel should be addressed to the Duke/UNC Oceanographic Consortium, Marine Laboratory, Duke University, Beaufort, North Carolina 28516.

Financial Information

Figures quoted in this section are projections and may be subject to change in many cases without prior notice. All rates are effective 5 May 1986 to 10 May 1987.

Room and Board Costs. All Duke University Marine Laboratory visitors who stay on the island will pay a room and board fee as follows: $22 per day (1-6 days); $135 per week (7 + days). Allowances will be made only for meals missed at the beginning and end of the stay.

Boat Rentals. The following boats are available at the laboratory for collecting and instructional activities. Charges apply to all research and teaching activities.

Boat Type	Charges
50 ft. cruiser/trawler (*First Mate*)*	$40 per hour
20 ft. outboard runabouts	$20 per hour
16 ft. outboard runabout	$12 per hour
Outboard skiffs	$4 per hour

*Crew required for safety of user and vessel.

These rates are intended to partially defray the cost of operating and maintaining these boats.

Most of these boats may be scheduled by visiting researchers through the Maintenance Office; however, first priority must be given to classes when they are in session. Use of Duke University Marine Laboratory vessels for any sponsored research will be subject to charges.

Research Space. Research space, including seawater tables, is available on a limited basis for Duke University Marine Laboratory visitors. Research space rent for all users is $2.25 per square foot per month. Typical size of laboratory-office area is 100 square feet. Requests for laboratory space, office space, and/or seawater tables should be sent to Personnel and Auxiliaries, Duke University Marine Laboratory, Beaufort, North Carolina 28516.

Teaching Space. Various size classrooms are available throughout the year; however, first priority must be given to Marine Laboratory classes when they are in session. Cost for such space is $25-$35/day depending upon which laboratory is utilized. Requests for these teaching areas, including class needs such as seawater tables, collecting equipment, etc., should be sent to Personnel and Auxiliaries, Duke University Marine Laboratory, Beaufort, North Carolina 28516.

APPLICATION FOR ENROLLMENT IN THE DUKE UNIVERSITY MARINE LABORATORY
UNDERGRADUATE MARINE SCIENCES PROGRAM

Please fill out completely; type or print.   Please specify: Spring Semester _____
                                                                                        Year

Date _____   Fall Semester   _____
                                                                                        Year

1. Mr., Ms. _____
                    Last   First   Middle

2. Social Security Number _____

3. Date of Birth: Month _____ Day _____ Year _____

4. A. Current full mailing address:

   Street or P.O. Box _____

   City _____State _____ Zip _____

   Telephone Number (including area code) _____

   B. Permanent or home full mailing address:

   Street or P.O. Box _____

   City _____State _____ Zip _____

   Telephone Number (including area code) _____

5. Name and full mailing address of parents or guardian:

   Name _____ Relationship _____

   Street or P.O. Box _____

   City _____ State _____ Zip _____

   Telephone Number (including area code) _____

6. **DUKE STUDENT** (only)

   A. Trinity _____ Engineering _____ Other (specify) _____

   B. Major _____

   C. Class (e.g., junior, senior) at time of enrollment at DUML _____

   D. Expected date of graduation _____

NOTE: Duke students must obtain the approval of their assigned departmental adviser on this application.

   E. Adviser's signature _____ Date _____

7. **NONDUKE STUDENT** (Students from institutions other than Duke who are attending for the semester only and who will be classified as special, nondegree students)

   A. Name and address of home institution:

   _____

   City _____ State _____ Zip _____

   B. Major _____

   C. Class (e.g., junior, senior) at time of enrollment at DUML _____

   D. Expected date of graduation _____

E. The following person has been requested to mail a letter of recommendation to the Admissions Office of the Duke University Marine Laboratory:

Name _____ Position _____

Institution _____

F. Transcript(s) will be sent by the following institution(s):

_____

_____

G. List courses currently in progress (which would not yet appear on a transcript):

_____

_____

H. Have you ever been placed on probation or suspended or dismissed from any school?

No _____ Yes _____ (If yes, please explain below.)

Mail Application to:

Admissions
Duke University Marine Laboratory
Beaufort, North Carolina 28516

Although this is not part of your official application and in no way will affect your application to the current program, we would consider it extremely helpful if you could provide us with the information requested below.

How did you learn about this program? _____

Has the program been adequately advertised? _____

Suggestions for better advertising: _____

APPLICATION FOR ENROLLMENT IN THE DUKE UNIVERSITY MARINE LABORATORY
SUMMER SESSION

Fill out completely; type or print.

Date _____

Mr., Ms. _____
              Last   First   Middle

Date of Birth: Month _____ Day _____ Year _____

Social Security Number _____

Current full mailing address:

    Street or P.O. Box _____

    City _____ State _____ Zip _____

    Telephone Number (including area code) _____

Permanent or home full mailing address:

    Street or P.O. Box _____

    City _____ State _____ Zip _____

    Telephone Number (including area code) _____

Name and full mailing address of parents or guardian:

    Name _____ Relationship _____

    Street or P.O. Box _____

    City _____ State _____ Zip _____

    Telephone Number (including area code) _____

DUKE STUDENT

    Undergraduate: Trinity _____ Engineering _____ Other (please specify) _____

    Graduate: Grad. Sch. Arts & Sci. _____ Sch. Forestry & Env. Studies _____

            Other (please specify) _____

    Class (e.g., junior, 1st yr. M.S.) at time of enrollment at DUML _____

    Expected date of graduation _____

    Major _____

NONDUKE STUDENT (Attending Summer Session only)

    Unclassified: Prebaccalaureate _____ Class (e.g., junior) _____

            Postbaccalaureate _____ Class (e.g., 1st yr. M.S.) _____

    Major _____

    Expected date of graduation _____

    If presently attending, list name and address of school: _____

    _____

    Have you previously attended Duke: No _____ Yes _____ (Give dates): _____

    Have you received a degree from Duke: No _____ Yes _____ (Give dates): _____

ALL STUDENTS (Applying to courses numbered 100 or higher)

List courses currently in progress (which would not yet appear on a transcript):

_____

_____

List other colleges and/or universities attended and degree(s) received: _____

EACH APPLICANT IS REQUIRED TO COMPLETE AND SUBMIT THIS APPLICATION BLANK AND TRANSCRIPT(S) (transcript required of students applying to courses numbered 100 or higher) OF ACADEMIC WORK COMPLETED TO DATE TO THE ADMISSIONS OFFICE. NOTE: A maximum of one 6 graduate unit or 1½ course program (6 semester hours) will be permitted per term (unless appropriate approval is obtained); FIRST AND SECOND CHOICES SHOULD BE INDICATED. LIST COURSE(S) DESIRED BELOW:

FIRST TERM:

Course Number   Course Title

1. _____

2. _____

(DUKE STUDENTS ONLY) Approval of assigned adviser; after May 4, Dean's approval required.

Adviser's/Dean's Signature _____ Date _____

SECOND TERM:

Course Number   Course Title

1. _____

2. _____

(DUKE STUDENTS ONLY) Approval of assigned adviser; after May 4, Dean's approval required.

Adviser's/Dean's Signature _____ Date _____

THIRD TERM:

Course Number   Course Title

1. _____

2. _____

(DUKE STUDENTS ONLY) Approval of assigned adviser; after May 4, Dean's approval required.

Adviser's/Dean's Signature _____ Date _____

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Beaufort, North Carolina 28516

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Suggestions for better advertising: _____

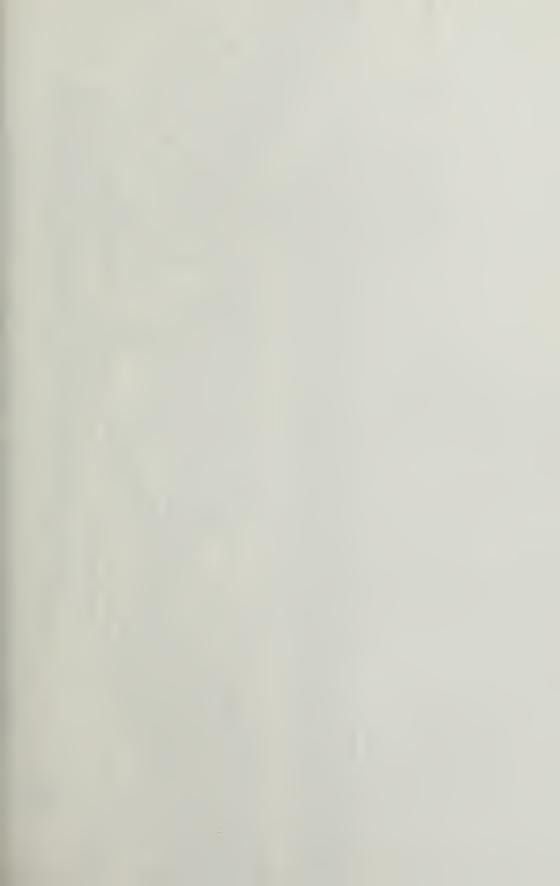## APPLICATION FOR ENROLLMENT IN THE DUKE UNIVERSITY MARINE LABORATORY UNDERGRADUATE MARINE SCIENCES PROGRAM

Please fill out completely; type or print.   Please specify: Spring Semester _____
                                                                                        Year

Date _____   Fall Semester   _____
                                                                                        Year

1. Mr., Ms. _____
              Last   First   Middle

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   Telephone Number (including area code) _____

   B. Permanent or home full mailing address:

   Street or P.O. Box _____

   City _____State _____ Zip _____

   Telephone Number (including area code) _____

5. Name and full mailing address of parents or guardian:

   Name _____ Relationship _____

   Street or P.O. Box _____

   City _____ State _____ Zip _____

   Telephone Number (including area code) _____

6. **DUKE STUDENT** (only)

   A. Trinity _____ Engineering _____ Other (specify) _____

   B. Major _____

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7. **NONDUKE STUDENT** (Students from institutions other than Duke who are attending for the semester only and who will be classified as special, nondegree students)

   A. Name and address of home institution:

   _____

   City _____ State _____ Zip _____

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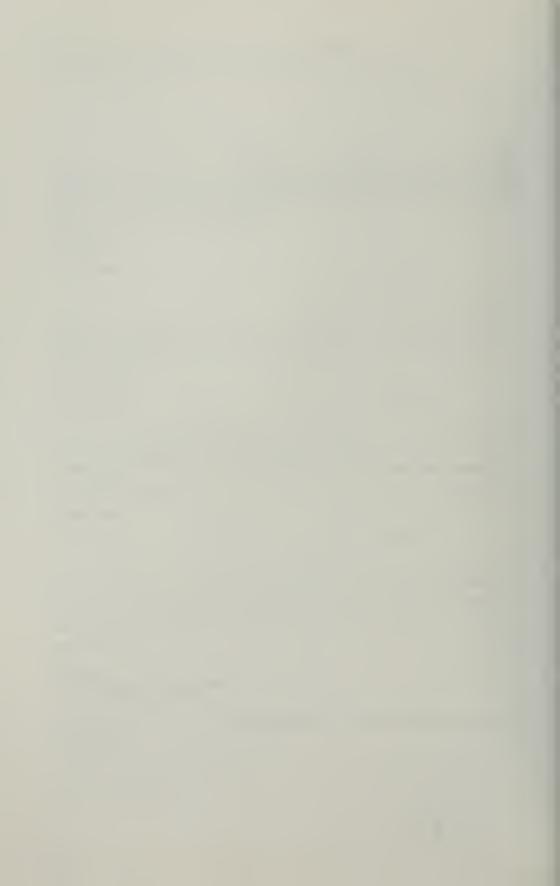
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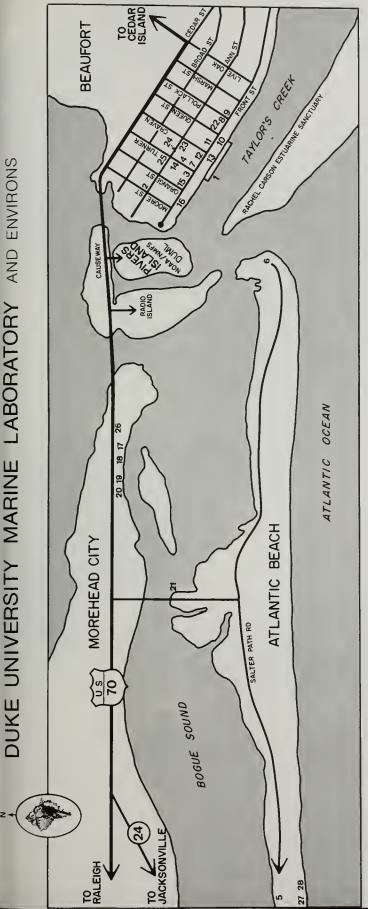
Suggestions for better advertising: _____

APPLICATION FOR ENROLLMENT IN THE DUKE UNIVERSITY MARINE LABORATORY SUMMER SESSION

Fill out completely; type or print.

Date _____

Mr., Ms. _____
  Last   First   Middle

Date of Birth: Month _____ Day _____ Year _____

Social Security Number _____

Current full mailing address:

  Street or P.O. Box _____

  City _____ State _____ Zip _____

  Telephone Number (including area code) _____

Permanent or home full mailing address:

  Street or P.O. Box _____

  City _____ State _____ Zip _____

  Telephone Number (including area code) _____

Name and full mailing address of parents or guardian:

  Name _____ Relationship _____

  Street or P.O. Box _____

  City _____ State _____ Zip _____

  Telephone Number (including area code) _____

DUKE STUDENT

  Undergraduate: Trinity _____ Engineering _____ Other (please specify) _____

  Graduate: Grad. Sch. Arts & Sci. _____ Sch. Forestry & Env. Studies _____

          Other (please specify) _____

  Class (e.g., junior, 1st yr. M.S.) at time of enrollment at DUML _____

  Expected date of graduation _____

  Major _____

NONDUKE STUDENT (Attending Summer Session only)

  Unclassified: Prebaccalaureate _____ Class (e.g., junior) _____

          Postbaccalaureate _____ Class (e.g., 1st yr. M.S.) _____

  Major _____

  Expected date of graduation _____

  If presently attending, list name and address of school: _____

  _____

  Have you previously attended Duke: No _____ Yes _____ (Give dates): _____

  Have you received a degree from Duke: No _____ Yes _____ (Give dates): _____

ALL STUDENTS (Applying to courses numbered 100 or higher)

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_____

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Adviser's/Dean's Signature _____ Date _____

SECOND TERM:

Course Number   Course Title

1. _____

2. _____

(DUKE STUDENTS ONLY) Approval of assigned adviser; after May 4, Dean's approval required.

Adviser's/Dean's Signature _____ Date _____

THIRD TERM:

Course Number   Course Title

1. _____

2. _____

(DUKE STUDENTS ONLY) Approval of assigned adviser; after May 4, Dean's approval required.

Adviser's/Dean's Signature _____ Date _____

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Beaufort, North Carolina 28516

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Has the program been adequately advertised? _____

Suggestions for better advertising: _____

DUKE UNIVERSITY MARINE LABORATORY AND ENVIRONS

BEAUFORT

TO CEDAR ISLAND

CEDAR ST
BROAD ST
ANN ST
MARSH ST
LIVE OAK ST
POLLACK ST
FRONT ST
QUEEN ST
CRAVEN ST
TURNER ST
ORANGE ST
MOORE ST

TAYLOR'S CREEK

RACHEL CARSON ESTUARINE SANCTUARY

CAUSEWAY
PIVERS ISLAND
DUML NOAA/NMFS
RADIO ISLAND

BOGUE SOUND

MOREHEAD CITY

US 70

SALTER PATH RD

ATLANTIC BEACH

ATLANTIC OCEAN

N

TO RALEIGH

TO JACKSONVILLE

24

POINTS OF INTEREST

1 BOARDWALK
2 COSTLOW HOME (201 ANN ST)
3 N.C. MARITIME MUSEUM
4 BEAUFORT RESTORATION
5 N.C. MARINE RESOURCES CENTER
6 FT. MACON STATE PARK
7 FIRST CITIZENS BANK
8 BRANCH BANKING & TRUST
9 U.S. POST OFFICE

RESTAURANTS

10 BEAUFORT HOUSE
11 MIKE'S
12 CLAWSON'S
13 DOCK HOUSE
14 NET HOUSE
15 THE CEDARS
16 SPOUTER INN
17 CHARTER
18 SANITARY
19 CAPT. BILL'S
20 OTIS' FISH HOUSE
21 CHANNEL MARKER

LODGING

15 THE CEDARS
22 INLET INN
23 LANGDON HOUSE
24 SHOTGUN HOUSE
25 CAPT'S QUARTERS
26 JEFFERSON
27 HOLIDAY INN
28 ATLANTIS

MILEAGES FROM DUML TO:

NEW BERN AIRPORT 37.5
JACKSONVILLE AIRPORT 60
KINSTON AIRPORT 80
WILMINGTON AIRPORT 85
RALEIGH/DURHAM AIRPORT . . . 160
DURHAM 180

bulletin of
Duke University
1987-88

Graduate School

bulletin of
Duke University
1987-88

Graduate School

The information in the bulletin applies to the academic year 1987-88 and is accurate and current, to the best of our knowledge, as of April, 1987. The University reserves the right to change programs of study, academic requirements, lecturers, teaching staffs, the announced University calendar, and other matters described in the bulletin without prior notice, in accordance with established procedures.

The *Bulletin of Duke University*, Volume 58, includes the following titles: *The Fuqua School of Business; The School of Forestry and Environmental Studies; Marine Laboratory; Undergraduate Instruction; The Graduate School; The Medical Center; The Divinity School; Information for Prospective Students; The Graduate School* (short form); *Allied Health Programs; The School of Law;* and *Information and Regulations.*

To the Prospective Graduate Student

A graduate school is where excellence is established in a university. At Duke, the Graduate School is where the two essential functions of a university, teaching and research, truly come together. Over the years Duke's strength at the graduate level has grown in all the main fields of knowledge. The nineteen-eighties have been particularly fruitful years for recruitment of faculty, establishment of new programs and attraction of outstanding students. The faculty enjoys international distinction. The laboratories, libraries, and computer facilities are among the very best. Yet the Graduate School remains small enough so that personal contact is a central feature of our programs, and fruitful interaction across disciplines is a common experience, both for faculty and students.

For the student in search of a strong graduate education, Duke University has much to offer. This is a community in which minds and ideas grow. We provide training for many careers, but we seek also to foster personal creativity and to provide stimulating yet congenial surroundings for productive education and research.

The following pages provide the information you require in making the important choice of the course of your graduate education. We look forward to welcoming you to the Duke community of scholars.

Malcolm Gillis
Dean of the Graduate School

University Administration

General Administration

H. Keith H. Brodie, M.D., *President*
Phillip A. Griffiths, Ph.D., *Provost*
William G. Anlyan, M.D., D.Sc., *Chancellor for Health Affairs*
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Graduate School Administration

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Executive Committee of the Graduate Faculty

Dean Malcolm Gillis

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Introduction

A Community of Scholars

Writing in the 1920s the philosopher and man of science, Alfred North Whitehead, defined the purpose of a university in these terms: "The justification of a university is that it preserves the connection between knowledge and the zest for life by uniting the young and the old in the imaginative consideration of learning." If this is true of a university generally, it is true of a graduate school especially. Faculty members and graduate students work together in the imaginative recasting of ideas necessary for successful research and the development of human knowledge.
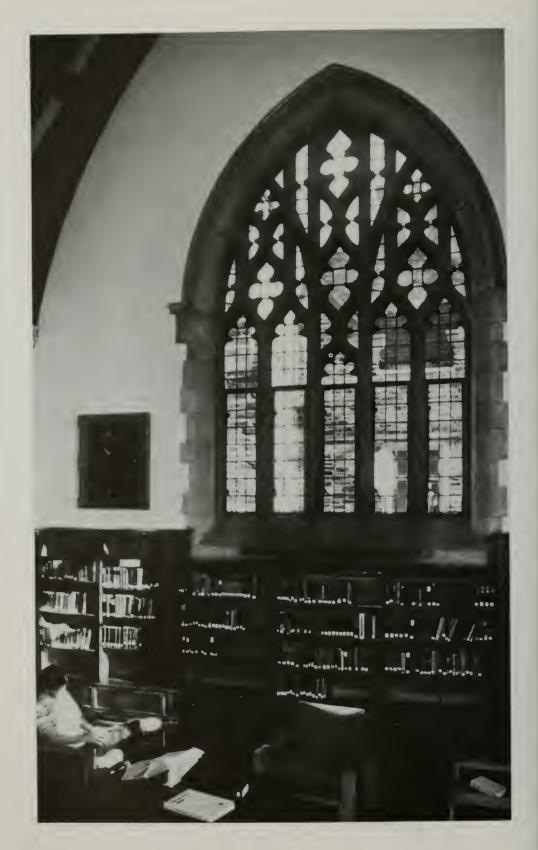
Ideally, a graduate school is a community of scholars engaged in imparting and extending the realm of human knowledge in the arts and sciences. A select group of students is admitted each year to undergo the rigorous discipline of an advanced degree program, the successful among them to emerge as scholars of promise. To enter into graduate education today is to accept a real challenge, and this decision should not be made casually. The work toward a doctorate requires several years of tireless effort and possibly sacrifice, and the material rewards may be less certain than in some alternative endeavor. However, pursued with determination, graduate education can be the doorway to a stimulating, creative, and meaningful life. The student who is contemplating this challenge may have many questions in mind; the material that follows is an attempt to answer some of them.

The Decision to Go to Graduate School

The decision to work toward an advanced degree must be a personal commitment born of a willingness to devote oneself to many months or possibly years of academic discipline just at an age when one may be impatient for financial independence and freedom from academic discipline. Graduate study requires all of one's energy and enthusiasm; to enter into it half-heartedly is to invite discouragement or failure.

Qualities instrumental for success in graduate study are a natural curiosity and the capacity for self-discipline. A good undergraduate record may or may not be adequate evidence of these characteristics. Many students with excellent undergraduate records have been unsuccessful in graduate study because their undergraduate training stressed the marshalling and articulation of facts rather than real understanding and analysis of material. On the other hand, many distinguished scholars had undistinguished undergraduate records. In gaining admission to a graduate school, the undergraduate record is, of course, an important element, but usually some margin is left to allow for

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students who develop serious academic interests late in their undergraduate careers. Students are often best able to judge for themselves whether their grades truly gauge their abilities.

There is no unerring way of knowing in advance whether one will be successful or happy in graduate school. It is quite likely, however, that if one has both motivation and ability and does not try it, there will be regrets in later years. Although the decision must be an individual choice, superior intellectual ability is a scarce human resource, and the encouragement and utilization of it is a matter of community as well as personal concern.

Choosing a Graduate School

Over 250 universities today offer work leading to the Ph.D. degree. Among these are about 60 institutions which grant only two or three such degrees a year in all fields combined. At the other end of the scale are about 50 universities which account for nearly 70 percent of all doctorates granted in this country. Duke University is among the latter, as are most of the major institutions which offer programs in a wide range of academic disciplines. But even if one can narrow the field to about 50 major institutions, how does one select among these, and what factors should affect one's final choice? A few key factors are discussed briefly below.

Size. Size is not an infallible guide to the quality of a graduate school. There are a number of poor graduate schools of exceedingly large size and a number of extremely good small ones. However, the ideal is a small number of superior students working closely in intellectual pursuits with a few esteemed scholars. It might be helpful simply to mention a few of the disadvantages of too many or too few students.

In an extremely large graduate school—there are some that have between 6,000 and 12,000 enrolled—classes of 50 to 100 students, inaccessibility of senior faculty, shortage of library materials and facilities, and only a nodding acquaintance with fellow students are a few of the possible drawbacks. An able student may develop well even in this atmosphere of mass production, but it is hardly the ideal.

An extremely small graduate school also has its disadvantages. Facilities are often limited, and the faculty is likely to be composed primarily of undergraduate instructors. A university must be willing to commit a significant portion of its resources to develop a graduate program of high quality, and this is often not the case in an extremely small graduate school.

More important than the size of the entire graduate school is the size of the particular departmental program in which a student is interested. An optimum doctoral program will have an enrollment of perhaps 30 to 100 students, admitting 15 to 40 new students each year and awarding perhaps three to ten Ph.D. degrees a year. This information is usually available in university catalogs or government publications on higher education.

Duke University is committed to programs of moderate size in which the interests of the student are important. Total enrollment in the Graduate School is 1,624 students. Between 500 and 550 new students are admitted each year from approximately 3,100 applications. Only six departments have more than 80 students; twenty-four departments have enrollments that fall within the optimum range suggested in the preceding paragraph.

Quality. Not only do universities differ considerably in their reputation for quality, but there are marked differences among departments within any university. Many excellent universities have a few weak departments in which a student would fare less well than in an excellent department in a less esteemed institution. Therefore, the student should not be guided solely by the reputation of a university as a whole, but should inquire more specifically about the area of specialization.

Since judging the quality of a graduate program is necessarily subjective, no two people are likely to be in complete agreement. Prospective students would do well to talk

with their undergraduate professors, particularly those who have themselves achieved some reputation in the world of scholarship. As witnessed by their own continuing writing and research, they are more likely to have reliable information on the merits of various graduate programs. Similarly, younger faculty members who are only four or five years out of graduate school may have more recent acquaintance with their own and other schools.

Another guide may be occasional questionnaires asking educators to rank various graduate departments.

Alone, none of these guides is adequate; however, in conjunction with individual advice and recommendations, they can serve as useful indicators. In summary, the best procedure is to take as many factors as possible into account, and then to apply to three or four of the schools high in consideration. (Applying to fifteen universities is a waste of the applicant's and the universities' time.) Write to the graduate school or to the departmental Director of Graduate Studies if further information is desired; visit the university in person, if possible; and carefully weigh the advice of distinguished faculty members of one's undergraduate college.

Duration of Program

The length of time a graduate student spends in study toward an advanced degree depends upon the requirements of the individual program, on personal work habits, and on the environment of the graduate school and the department in which the study is conducted.

The student's level of preparation before entering graduate school has a direct bearing on the speed with which the degree may be earned. A student who enters with proficiency in one or more foreign languages and a good foundation in the chosen field may well be able to finish within the minimum time limits. On the other hand, the student who is not as well prepared may find that one and a half to two years are the minimum for the A.M. degree, and four to five years for the Ph.D. degree (although wise use of the summers may reduce this time somewhat). The total time may also be lengthened if the student must work during part of the period of residence.

The attitude of the graduate school and its various departments will also affect the time needed to complete the degree. During the last decade the average time elapsing between entering graduate school and receiving the doctorate in American universities has been about ten years. At Duke the average doctorate in the humanities requires a little over seven years, nearly six years in the social sciences, and slightly over four years in the sciences. Over the last few years, Duke University has been among the forerunners in reducing even further the time needed to obtain the Ph.D. without any sacrifice in quality. This effort has taken the form of trying to eliminate the unnecessary delays, particularly those due to financial burdens on the student. Duke ranks among the leading institutions in the country today in terms of financial aid per student from university sources. Moreover, much of this aid is in the form of fellowships and scholarships which do not require burdensome services in return. The large public institutions are often more restricted to awards which require substantial teaching, research, or other duties, thus reducing the speed with which a student can complete the resident course work. A student will be wise to inquire to what extent progress toward a degree may be delayed by the work entailed in certain awards. If, for example, an assistantship lengthens unduly the time necessary to obtain a degree, a smaller fellowship may be preferable. The duration of the graduate program depends on several factors, but the policy of the Duke Graduate School is to keep the length of time a student is involved in obtaining an advanced degree at a minimum.

Duke University Graduate School

Teaching and Research

In surveying the progress made in the first seven years after the founding of Duke University, its first President, William Preston Few, wrote that he wanted "to see the Graduate School made strong because it will best and most quickly ensure our attaining and maintaining a place of real leadership in the educational world." President Few believed that "more than anything else here our Graduate School will determine the sort of University we are to build and its standing in the educational world." This conviction has continued to prevail to the present day, with emphasis upon the interdependence of teaching and research as the necessary components of scholarship.

Over 700 members of the graduate faculty teach the approximately 900 courses and seminars offered in the Graduate School and supervise thesis and dissertation research. Many of the major universities of the world have helped to train this faculty; approximately 90 percent of the graduate staff hold degrees from the 52 institutions which make up the Association of Graduate Schools within the Association of American Universities. By place of birth, the faculty represent almost every state in the nation and almost two dozen foreign countries.

The groundwork for learning may be laid in privacy—indeed a certain amount of private study and research is absolutely essential—but the vital stimulus to the learning process comes from one's contact with the minds of other people with similar or related interests. This is precisely why graduate schools are highly selective in their admissions policies, and it is one of the important reasons for their willingness to offer attractive fellowship awards to outstanding students. The superior student is a valuable catalyst both for fellow students and for faculty and is prized as such.

Faculty and students comprise the essential human factor in education, but their joint endeavor cannot prosper without adequate research and library facilities. Duke University has research facilities for physics, botany, zoology, chemistry, psychology, sociology, engineering, and biochemistry, as well as well-equipped laboratories in the various departments of medical science. They have been built entirely, or modernized and expanded, within recent years. The University has an excellent Computation Center on the campus and shares a computing facility with the University of North Carolina and North Carolina State University. The Triangle Universities Computation Center is among the largest research-oriented computer facilities in the world. The University has an excellent research library. In number of volumes, serials, and documents, and in

breadth of coverage, the library offers more resources than many graduate schools with enrollments two or three times Duke's size. To the student in the arts, humanities, or social sciences, this is an immeasurable asset.

Among the many special features of the Graduate School a few important examples may be mentioned. For students in the biological and physical sciences, the facilities of the Duke Marine Laboratory at Beaufort, North Carolina, are available for course work and research. The laboratory has research buildings, classrooms, research vessels, and living quarters which make it an excellent research center in marine biology. Closer to home are the 8,300 acres of Duke Forest, managed by the School of Forestry and Environmental Studies, ideal for research on timber growth, soils, and related topics. A regional nuclear structure laboratory is housed on the campus and serves the major universities in the area. The phytotron, adjacent to the botany greenhouses, is an integrated series of plant-growth rooms, chambers, and greenhouses, with forty-six separately controlled environments providing more than 4,000 square feet of plant-growing space. The environmental factors controlled in the units for the study of plant growth include light, temperature, nutrients, carbon dioxide concentration, and humidity.

Additional resources and facilities are available to the graduate student through Duke's fine Schools of Law, Business, Medicine, Engineering, Forestry and Environmental Studies, and the Divinity School. A two-term summer session and the availability of courses at the nearby University of North Carolina at Chapel Hill, North Carolina Central University in Durham, and North Carolina State University in Raleigh, under a cooperative arrangement, offer other opportunities to the graduate student.

No description of programs can begin to give the prospective student the full flavor of graduate study in a particular institution. If practical, a visit to the universities in which one is interested is always helpful. The Duke Graduate School offers a warm invitation to prospective students to come to the campus during the year to discuss their possible application and admission.

The visitor will find at Duke most of the facilities that one could hope for in the largest of institutions, and yet the University has been fortunate in avoiding many of the evils that seem inevitable with mass education. Despite a total University enrollment of approximately 9,500, Duke has retained the sense of community that one usually associates with a small liberal arts college. And in an age when current architectural whim often adds yet another stylistic variant to an already eclectic array of buildings, Duke has built a campus of unusual and architecturally coherent beauty. This, too, is an important part of education, creating an environment conducive to learning.

Special Programs

Center for the Study of Aging and Human Development. The primary aims of the center are to encourage and support basic and applied research on biomedical, behavioral, and social scientific aspects of adult development and aging; to train investigators for such research; to provide clinical training in geriatrics for health professionals; and to develop sources of scientific information which are accessible to interested individuals, organizations, and governmental agencies. Although the center does not offer degrees, the varied programs, research laboratories, and clinical settings provide a context and resource for undergraduate and graduate students and for health professionals with special interests in adult development and aging. Inquiries should be addressed to the Director, Center for the Study of Aging and Human Development, Box 3003, Duke University Medical Center, Durham, North Carolina 27710.

Asian-Pacific Studies Institute. The purpose of the Asian-Pacific Studies Institute is to encourage and support advanced training in Asian-Pacific studies and in Chinese, Japanese, and other Asian-Pacific languages. The institute sponsors an agenda of visiting speakers and scholars and coordinates study abroad programs in China and Japan. A limited number of fellowships are granted which provide stipends for a two-year period.

Fellows will be expected to reach the equivalent of third-year level of proficiency of language training during the term of their award. Incoming graduate students with the Ph.D. as their objective, students in good standing in the first year of study in Duke professional schools, and current Duke students enrolled in Ph.D. programs may be considered for these fellowships. Further information may be obtained from the Director, Asian-Pacific Studies Institute, 2111 Campus Drive, Duke University, Durham, North Carolina 27706.

Canadian Studies Program. The purpose of this program is to increase American knowledge and understanding of Canada by formalizing and expanding graduate interest in Canada, introducing the study of Canadian life and culture at the undergraduate level, and encouraging such study in primary and secondary schools. The program awards a limited number of graduate fellowships and teaching assistantships for the study of Canada by American residents at Duke who are working in their departments on a Canadian topic for their dissertations; sponsors lectures by Canadian specialists; and supports seminars devoted to Canada, held off and on campus. Inquiries should be addressed to the Director, Canadian Studies Center, 2016 Campus Drive, Duke University, Durham, North Carolina 27706.

The University Program in Cell and Molecular Biology. This program centralizes the cell, developmental, and molecular biology research training found in eight of the University's departments: anatomy, biochemistry, botany, microbiology and immunology, pathology, pharmacology, physiology, and zoology. Prospective students may either apply to one of the participating departments, or apply directly to the program and designate a departmental preference. Applications for admission and fellowship support must be received by February 1, but early applications may receive advanced consideration. Inquiries should be addressed to Dr. Bernard Kaufman, The University Program in Cell and Molecular Biology, Box 3711, Duke University Medical Center, Durham, North Carolina 27710.

Continuing Education. Local adult residents may pursue graduate academic study at Duke as nondegree students through the Office of Continuing Education, which will provide both academic and career counseling to such students. GRE workshops are also offered regularly. Information and applications may be obtained from the Office of Continuing Education, The Bishop's House, Duke University, Durham, North Carolina 27708.

Cooperative Programs with Neighboring Universities: Library Exchange. Through a cooperative lending program, graduate students of the University of North Carolina and Duke University are granted library loan privileges in both universities.

Cooperative Program in Russian and East European Studies. The graduate schools of Duke University and the University of North Carolina offer a cooperative program leading to the A.M. and Ph.D. degrees in several disciplines (economics, history, literature, linguistics, political science, and sociology), with a concentration in Russian and East European studies. Students admitted to one institution are encouraged to enroll in courses advantageous to their programs at the other institution, to utilize the libraries and facilities of both universities, and to participate in the periodic colloquia involving the personnel of the two institutions and distinguished visiting scholars. For information, contact Dr. Stefan Pugh or Dr. Edna Andrews, Department of Slavic Languages, Duke University, Durham, North Carolina 27706.

Center for Demographic Studies. The facilities of the center, located at 2117 Campus Drive, include a population library, the Joseph J. Spengler Collection of publications and research materials, and extensive data resources. These are available to the entire Duke community. The Center does not offer degrees; it promotes the pursuit of advanced degrees, with a specialization in population studies, through either the Department of Sociology or the Department of Economics. The center's program provides opportunities

for direct student participation in ongoing research projects. The program of extramural research stresses, but is not limited to, work in the demography of aging, health, mortality, fertility, and migration. Inquiries for training and research opportunities may be directed to Dr. George C. Myers, Director, Center for Demographic Studies, 2117 Campus Drive, Durham, North Carolina 27706.

Center for Environmental Engineering. The purposes of the Center for Environmental Engineering are to focus attention on pressing environmental problems, to provide orientation and educational opportunities in technical environmental subjects for both students and faculty, and to promote interdisciplinary environmental engineering research. The center sponsors a visiting speaker program and graduate and faculty seminars, and coordinates graduate and undergraduate courses in environmental engineering. Further information may be obtained by writing or visiting the Center for Environmental Engineering Office, 133 School of Engineering, Duke University, Durham, North Carolina 27706.

The University Program in Genetics. This is an interdisciplinary program with a faculty drawn from several of the biological science departments (anatomy, biochemistry, botany, microbiology and immunology, zoology), and is designed to meet the needs of students with a variety of educational backgrounds and professional objectives who are interested in specializing in the field of genetics. Interested students should apply for admission to the department of their choice, and after being admitted make arrangements to participate in the program. For information, consult Dr. J. Antonovics, Director, The University Program in Genetics, 132 Biological Sciences Building, Duke University, Durham, North Carolina 27706.

Master of Arts Program in Humanities. This interdepartmental program centered in the humanities and leading to the A.M. degree is designed for students whose interests cross disciplinary lines and are not easily met by departmental programs. Students select a set of thematically related courses from the graduate level offerings of humanities departments, and, where appropriate, from other departments as well. The interdepartmental committee which manages the program offers aid in tailoring a set of courses to the individual student's needs, approves the program chosen, and provides ongoing supervision. Information on program requirements and admission may be found in the chapter on "Advanced Degree Programs." Additional information may be obtained by writing the Director of Graduate Studies, Master of Arts Program in Humanities, The Graduate School, 127 Allen Building, Duke University, Durham, North Carolina 27706.

Duke University International House. International House is the center of cocurricular programs for the more than four hundred students from sixty-six countries who are presently enrolled at Duke. Programs which assist students from abroad in participating in the life of the Durham and Duke communities include: an intensive orientation program at the beginning of the academic year; the Host Family Program in which interested international students may become acquainted with American families; the International Wives Club, which provides a structure for international women to meet with American women in an informal atmosphere; the Speakers' Bureau, which arranges for international students to speak at civic and social groups as well as schools in the Durham community; the Friday coffee break in the basement of the Chapel which is sponsored by Campus Ministry especially for internationals and friends. The International Association is a student organization which includes a significant number of American members, as well as international students. The Association plans social and cultural programs which emphasize personal contact and the informal exchange of ideas among students from diverse backgrounds. Included are weekly open-houses with lectures, films, pot-luck dinners, or parties; periodic trips outside of Durham; and an annual International Day on campus which draws visitors from throughout the area. Additional information may be obtained by writing to Carlisle C. Harvard, Director, International House, 2022 Campus Drive, Duke University, Durham, North Carolina 27706.

Islamic and Arabian Development Studies. This program, begun in 1977 with the assistance of grants from the government of Saudi Arabia and some twenty corporations in the United States, sponsors conferences and research on Islamic themes with special reference to developmental problems of the Arabian peninsula. The program has supported courses and seminars on the language, art, and contemporary problems of the Islamic world. It sponsored student delegations to the annual Model Assembly of the League of Arab States in Washington, D.C. The 1984 delegation won the highest number of awards given to any participating university. Twelve faculty members from outreach colleges were awarded fellowships for study in Cairo and six Duke faculty were given fellowships for study in Jordan in 1984. The program was the recipient of a bequest by the late Joseph J. Malone of his library in Arabian affairs. The program also arranged for acquisition by Perkins Library of the Louis and Nancy Hatch Dupree Collection on Islamic Central Asia. The program has sponsored four international conferences, two at Duke, one at Kiawah Island and the fourth at the Rockefeller Foundation Conference Center, Bellagio, Italy. The program also sponsors an outreach program which includes Appalachian State University, Belmont Abbey College, the College of Charleston, Converse College, Davidson College, Johnson C. Smith University, Old Dominion University, and the University of the South. Inquiries should be addressed to Dr. Ralph Braibanti, Director, Islamic and Arabian Development Studies, 2114 Campus Drive, Duke University, Durham, North Carolina 27706.

Latin American Studies Program. The Graduate School offers an interdepartmental program in Latin American studies in conjunction with several departments. Students apply to the Departments of Anthropology, History, Economics, Political Science, Sociology, or Romance Languages, fulfilling the requirements of those departments and writing their A.M. and Ph.D. degrees under their auspices. In consultation with the candidate, a faculty committee will determine a special program of study giving the candidate rigorous training in the Latin American field in addition to their disciplinary training. The holdings of the Perkins Library for graduate work and research in Latin-American history, inter-American relations, economic history, politics, art, and Spanish-American literature are constantly being enlarged. Program faculty are involved in different national research programs dealing with Latin American topics and offer advice on fellowship support for graduate research in Latin America and the Caribbean. Inquiries should be directed to the council on Latin American Studies, Center for International Studies, 2122 Campus Drive, Duke University, Durham, North Carolina 27706.

Master of Arts in Liberal Studies. The Master of Arts in Liberal Studies is an interdisciplinary program that allows individuals with a variety of professional and personal educational interests the flexibility to pursue those interests across traditional disciplinary boundaries. The program is managed by an interdepartmental committee which advises students and directs their course of study. Students will study primarily on a part-time basis and will choose from an array of interdisciplinary courses developed specifically for this program. In addition, the students will select other graduate-level courses that fit their individual needs and interests. For further information, call or write Director, Master of Arts in Liberal Studies Program, Room 122 Allen Building, Duke University, Durham, North Carolina 27706, (919) 684-3222.

The Ph.D. Program in Literature. This program offers to qualified students the possibility of gaining unusually broad credentials with which to embark on a teaching career in established national literatures as well as programs linking literature to other fields. Study in depth through courses in a single national literature is combined with a series of four core courses, given in a two-year sequence, on the fundamental issues of literary theory, history, and criticism. All the literature departments cooperate in this program and its students have access to all courses given under the auspices of the graduate faculties in the humanities. A full descriptive brochure is available. To obtain

the brochure or other information, contact Dr. James Rolleston, Chairman, Committee for the Ph.D. in Literature, Department of Germanic Languages and Literature, 104 Language Building, Duke University, Durham, North Carolina 27706.

Medical Historian Training Program. Conducted under the auspices of the School of Medicine and the Graduate School, this program requires a minimum of six years of graduate study for the M.D.-Ph.D., and four or five years for the M.D.-A.M. The M.D.-Ph.D. program is intended for those students who know that their major career effort will be in teaching and other scholarly activities in the history of medicine (not necessarily to the total exclusion of clinical medicine). The M.D.-A.M., on the other hand, is appropriate for those who are undecided, but who wish to acquire a firm foundation for future study, or for those who are seriously interested in pursuing an avocation in the history of medicine. Applicants must meet the requirements for admission to the School of Medicine and the Graduate School in the Department of History. Inquiries should be addressed to Dr. Peter English, Director, Medical Historian Training Program, Box 3420, Duke University Medical Center, Durham, North Carolina 27710.

Medical Scientist Training Program. This program is conducted under the auspices of the Graduate School and the School of Medicine and is designed for students with a strong background in science who are motivated toward a career in the medical sciences and academic medicine. It provides an opportunity to integrate graduate education in one of the sciences basic to medicine with the clinical curriculum of the School of Medicine, and usually requires six to seven years of study leading to both the M.D. and Ph.D. degrees. Interested students should apply for admission to both the Graduate School and the School of Medicine. Additional information may be obtained by consulting Dr. Salvatore Pizzo, Director, Medical Scientist Training Program, Department of Pathology, Box 3712, Duke University Medical Center, Durham, North Carolina 27710.

Program in Medieval and Renaissance Studies. This program is administered by the Duke University Center for Medieval and Renaissance Studies. A participating student is enrolled in one of the regular departments and fulfills the Ph.D. requirements for that discipline while taking a program of electives which will advance his or her interdisciplinary competence in the medieval or Renaissance areas. Such a program may include a choice from the fields of art history, language and literature, history, philosophy, and religion. Participation in the program will fulfill the Graduate School requirement for work in a related field. Inquiries should be addressed to the Director of Graduate Studies, Duke University Center for Medieval and Renaissance Studies, Box 4666, Duke Station, Durham, North Carolina 27706.

The University Program in Neurobiology. This interdisciplinary program was developed in response to recent advances in neurobiology which have resulted in closer ties among the various approaches to studying the nervous system. The program is designed for students who wish to study the nervous system at several levels ranging from the molecular to the behavioral, and students will be advised to take courses in neuroanatomy, neurophysiology, neuropharmacology, and neuropsychology. The heart of the training is a research apprenticeship that leads to a Ph.D. dissertation. Each student must affiliate with one of the participating departments—anatomy, biochemistry, microbiology and immunology, pathology, pharmacology, physiology, psychology, and zoology—and must meet the requirements of that department for the Ph.D. degree. Prospective students should apply directly to one of the eight participating departments, and should indicate on the application their interest in the University Program in Neurobiology. Inquiries should be directed to Dr. Irving T. Diamond, Director, University Program in Neurobiology, Department of Psychology, Duke University, Durham, North Carolina 27706.

Oak Ridge Associated Universities. Duke University is one of the sponsoring universities of the Oak Ridge Associated Universities located at Oak Ridge, Tennessee. The graduate research program at Duke has available to it all of the facilities of the Oak Ridge National Laboratory and the cooperative supervision of student research by the staff at Oak Ridge. Fellowships in several fields of science are available to qualified applicants. Further information may be obtained from Dr. Merrell L. Patrick, Department of Computer Science, 104 North Building, Duke University, Durham, North Carolina 27706.

Institute of Policy Sciences and Public Affairs. See Public Policy Studies in the chapter on "Advanced Degree Programs" in this bulletin.

Center for Resource and Environmental Policy Research. Housed in the School of Forestry and Environmental Studies, the center combines the efforts of a small permanent faculty with participation by business leaders, government officials, and the faculty and students of Duke University and other universities to provide a center of excellence for the analysis of contemporary resource and environmental policy issues, a forum for the examination of public and private responsibilities for natural resources and the environment, and a link between the specialized knowledge of academia and the information needs of government and industry. Graduate research assistantships are offered to qualified students researching resource and environmental policy problems. Support is available to students pursuing M.S., A.M., or Ph.D. degrees through the Graduate School at Duke University and in conjunction with the School of Forestry and Environmental Studies or other departments. Course work is offered in both intensive (one to three weeks) and semester-long formats. For further information, write to Dr. William Hyde, Center for Resource and Environmental Policy Research, 102 Biological Sciences Building, Duke University, Durham, North Carolina 27706.

The University Program in Toxicology. This interdepartmental program provides graduate students and postdoctoral fellows with an opportunity for a strong education in toxicology through support of courses, seminars, and research. The objectives of program members are to understand and devise controls for those toxicological phenomena having direct effects on human life and health, to train scholars who will advance the science of this discipline, and to provide a forum for faculty and student discussion of recent research developments. The faculty of the toxicology program is drawn from anatomy, biochemistry, chemistry, forestry and environmental studies, microbiology and immunology, pathology, pharmacology, physiology, zoology, and several departments in the School of Medicine. Current areas of research include pulmonary toxicology, neurotoxicology, immunotoxicology, carcinogenesis, and biochemical toxicology. Students may base their training in general toxicology, ecotoxicology, or any area in which the faculty is currently involved. Prospective graduate students may apply to the program directly or to one of the participating departments, and must be admitted both to the department and to the program. Information on fellowship support and application procedures may be obtained from Dr. Doyle G. Graham, Director, University Program in Toxicology, Box 3712, Duke University Medical Center, Durham, North Carolina 27710.

Organization for Tropical Studies. Duke University is a member of an international consortium created to promote an understanding of tropical environments through research and research-training programs in the tropics. A basic eight-week OTS course in tropical biology is conducted twice a year, and advanced course offerings are scheduled periodically in agriculture, botany, forestry, geography, and zoology. For information, consult Dr. Donald Stone or Dr. Richard White, Department of Botany; or Dr. John Lundberg, Department of Zoology; Duke University, Durham, North Carolina 27706.

Short Courses and Conferences. Short courses, institutes, and training programs are conducted throughout the year by the Office of Continuing Education. Some are residential, others are designed for local participants; some carry academic credit, others award continuing education units (CEU); still others are noncredit. Previous programs

have included Federal Regulations, Writers' Conferences, Energy Conservation in Buildings, School Management, Product Safety, the Computer Camp, and the Summer Institute of Alcohol Studies. Contact Dr. Judith Ruderman, Director, Office of Continuing Education, The Bishop's House, Duke University, Durham, North Carolina 27708, for brochures describing current offerings and for assistance in developing programs.

Duke Summer Festival of the Arts. The Duke Summer Festival of the Arts is part of the Summer Session and an extension of the function of the Office of Cultural Affairs, coordinating the arts in the summer and providing an exciting, artistically stimulating environment for the campus and community. The Ciompi Quartet, Duke's well-known Chamber Music Ensemble, will give several performances during the summer. Other special events are planned. Distinguished artists and scholars will be involved in cocurricular sessions. Students will have the opportunity to participate in informal productions. The 1987 Summer Festival will be enhanced by funds from the Arts Celebration, the performing arts component of the N.C. Amateur Sports, sponsor of the 1987 U.S. Olympic Festival scheduled for July 15-26. Specific course listings can be found under art, drama, music and dance.

Summer Theater Institute. The Summer Theater Institute, established for students seriously interested in theater, offers intense professional-level training that does not fit the regular school year's activities. Institute instructors are working theater professionals with extensive teaching experience. Courses involve substantial contact time and carefully prepared assignments. Students must be willing to develop the necessary degree of professional concentration. Primary Stages Theater Company, one of New York City's most exciting young companies, under the artistic directorship of Casey Childs (who directed Duke Drama's acclaimed October show, *Ring Round The Moon*), will be in residence for much of the first term of summer session. Professional actors, directors and playwrights will involve students in developing new scripts through rehearsals and readings. Company members will be available to guide students in workshop activities. Primary Stages has quickly established a reputation for extending the traditional boundaries of playwriting and directing, and this summer residency marks the beginning of a long-term relationship between this noted group from Manhattan and Duke Drama. Detailed information on faculty and courses may be obtained by writing to Summer Theater Institute, Duke University, Box 6841 College Station, Durham, North Carolina 27708.

The American Dance Festival. The six-week program offers a wide variety of classes, performances, and workshops. For a catalog, write to the American Dance Festival, Duke University, Box 6097 College Station, Durham, North Carolina 27708.

General Regulations Governing Graduate Studies

The official, detailed *Bulletin of Duke University: Graduate School*, published in March of each year, gives an account of regulations concerning graduate work at Duke University and a full description of course content. The following pages are a summary of these materials for 1987-88 and should provide sufficient information, together with the application packet, for the prospective student. The bulletin is normally mailed to each student who is admitted to the Graduate School in the late spring of the year of matriculation so that the course program may be planned for the first year.

Admission

All students seeking a graduate degree from Duke University must formally be admitted to the Graduate School. Applicants are considered without regard to race, color, religion, sex, age, handicap, or national origin.

Prerequisites for admission include a bachelor's degree (or the equivalent) from an accredited institution. The student's undergraduate background should be well-rounded

and of high quality, indicating ability for graduate study. Ordinarily the student should have majored in the area of intended graduate study. Many departments (see the section on "Advanced Degree Programs") list specific prerequisites. Satisfactory scores on the Graduate Record Examination are required by all departments.

Many graduate departments will consider applications from students wishing to pursue degree study on a full-time or part-time basis. (Consult application materials for listing of departments.) Admission requirements, procedures, and deadlines are the same for both full- and part-time students. Part-time study requires a minimum registration of 3 units per semester, and while it is possible to obtain the master's degree on a totally part-time basis, the Ph.D. degree does require a minimum of one year of full-time residence. Additionally, students must maintain continuous registration from entry into the Graduate School to completion of degree. Time limits for completion of degrees are the same for both full- and part-time students. Financial aid through Duke University is not available to part-time students (except during their year of full-time residence). Visa restrictions do not allow nonimmigrant students to pursue graduate study on a part-time basis.

Students who do not intend to earn an advanced degree at Duke, but who wish to take graduate courses, may apply for nondegree admission. Such admission is granted in three different categories: (1) admission as a regular nondegree student in the Graduate School, which involves application to a particular department and fulfillment of standard application procedures and requirements; (2) admission as a special nondegree student through the Office of Continuing Education in conjunction with the Graduate School, without departmental affiliation, following special application procedures; and (3) admission as an unclassified student in the summer session only, requiring application to the Director of the Summer Session.

Procedures. A student seeking admission to the Graduate School should obtain an application packet from the Graduate School Admissions Office. (Note: Persons interested in the Master of Arts in Liberal Studies should contact that program directly for information, requirements, and special application materials.) This packet contains the necessary forms and detailed application instructions. The application form must be filled out completely, signed, and returned to the Graduate Admissions Office accompanied by a nonrefundable fee of $45 in U.S. currency (check or money order payable to Duke University). In addition, the student should provide the following supporting documents: (1) two copies of the official transcript from each post-secondary institution attended sent directly to the Graduate School by the institution; (2) three letters of evaluation from persons best qualified to judge the applicant as a prospective graduate student, written on the forms provided and returned by the applicant in the confidential envelopes that have been sealed-then-signed by the evaluators (or returned directly to the Graduate School by the evaluator); (3) official scores on the Graduate Record Examination General Test for applicants to all departments; and (4) official scores on the Graduate Record Examination Subject Test for applicants to certain specified departments (see application materials). Students applying for fall admission and award should take the Graduate Record Examination no later than the October testing in the previous year to meet our deadlines. Information on the times and places of the Graduate Record Examination can be provided by the applicant's college or by the Educational Testing Service, CN 6000, Princeton, New Jersey 08541-6000.

Materials submitted in support of an application are not released for other purposes and cannot be returned to the applicant.

Fully qualified students from outside the United States may apply for admission to full-time study in the Graduate School. The foreign student must, in addition to the information required of all students, submit the following materials with the application: (1) if the student's native language is not English, certification of English proficiency

demonstrated by official scores from the Test of English as a Foreign Language (TOEFL), administered through the Educational Testing Service, CN 6155, Princeton, New Jersey 08541-6155 (the Graduate School requires a score of 550 or higher on the TOEFL); (2) a statement showing financial arrangements for the proposed term at Duke (estimated costs per calendar year are about $17,500). Foreign students may apply for full-time study only.

During new matriculants' first registration period at Duke, every foreign student whose native language is not English will be required to take a test to verify competence in the use of oral and written English. Until such competence is determined, admission and arrangements for an award involving teaching must remain provisional. Students found to lack the necessary competence should be prepared to undertake additional English language instruction. Students who do not successfully pass the test for competence in oral and written English by the end of their first year of residency will not be permitted to continue graduate work at Duke University. Please note that the competency test does not take the place of the TOEFL 550 requirement, nor does passing the competency examination meet degree requirements for a foreign language.

It is the applicant's responsibility to make certain that the Graduate School Office has received all required materials before the specified deadlines, which are outlined at the close of this chapter and detailed in the application materials. To ensure that the Admissions Office will have adequate time to assemble all items submitted on an applicant's behalf, applications should be submitted at least two weeks before the deadline. Only complete applications can be considered. Anyone whose folder is not complete by the deadline will face the possibility that departmental enrollment will have been filled and that all financial aid funds will have been committed based on applications that were complete as of the deadline.

Applicants who are admitted will be offered full admission, provisional admission, or nondegree admission and will receive a letter of admission from the Dean of the Graduate School and an acceptance form. Admission to the Graduate School is offered only by the Dean. The process of admission is not complete until the student returns the acceptance form. An admission offer is only for the semester specified in the letter of admission, and admission may not be deferred automatically from one term to another. *Provisional admission* for a trial period of one semester or a minimum of 12 hours of course work is offered to students who appear to warrant admission but do not comply fully with admission requirements. Graduate credit earned under provisional status may be applied toward an advanced degree at Duke University if and when the student is granted full admission. *Nondegree admission* is offered to students who meet the admission requirements and who desire to engage in graduate study not subject to the restrictions of a graduate degree program. With the approval of the student's major department and the Dean of the Graduate School, a maximum credit of 12 graduate units earned under nondegree status may be applied toward an advanced degree at Duke University if and when the student is granted full admission.

Immunizations. North Carolina Statute G.S.: 130A-155.1 states that no person shall attend a college or university, public, private, or religious, excluding students attending night classes only and students matriculating in off-campus courses, unless a certificate of immunizations against diptheria, tetanus, whooping cough, poliomyelitis, red measles (rubeola), and rubella is presented to the college or university on or before the first day of matriculation.

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Earning the Degrees

Duke University offers graduate programs leading to the specified advanced degrees in the following fields: *

Anatomy, Ph.D.
Anthropology, Ph.D.
Biochemistry, Ph.D.
Biomedical Engineering, M.S., Ph.D.
Botany, A.M., M.S., Ph.D.
Business Administration, Ph.D.
Chemistry, Ph.D.
Civil and Environmental Engineering, M.S., Ph.D.
Classical Studies, A.M., Ph.D.
Computer Science, M.S., Ph.D.
Economics, A.M., Ph.D.
Electrical Engineering, M.S., Ph.D.
English, A.M., Ph.D.
Forestry and Environmental Studies, A.M., M.S., Ph.D.
Geology, M.S., Ph.D.
Germanic Languages and Literature, A.M.
Health Administration, M.H.A.
History, A.M., Ph.D.

Humanities, A.M.
Liberal Studies, A.M.
Literature, Ph.D.
Mathematics, A.M., M.S., Ph.D.
Mechanical Engineering and Materials Science, M.S., Ph.D.
Microbiology and Immunology, Ph.D.
Musicology, A.M., Ph.D.
Pathology, M.S., Ph.D.
Pharmacology, Ph.D.
Philosophy, A.M., Ph.D.
Physical Therapy, M.S.
Physics, A.M., Ph.D.
Physiology, Ph.D.
Political Science, A.M., Ph.D.
Psychology, Ph.D.
Public Policy Studies, A.M.
Religion, A.M., Ph.D.
Romance Languages, A.M., Ph.D.
Sociology, A.M., Ph.D.
Zoology, Ph.D.

The Language Requirement

Although individual departments establish their own requirements (see individual departmental headnotes in the section on "Advanced Degree Programs"), the regulations of the Graduate School require no foreign language for the master's degree or for the Ph.D. degree. The languages normally required by departments are French, German, and Russian, but others may be offered if appropriate and approved.

The foreign language may be satisfied in the following ways: (1) by a passing score on one of the Graduate School Foreign Language Test (GSFLT) examinations administered at any national center prior to entering Duke or at Duke University after matriculation and taken no longer than six years before the preliminary examination, (2) by transfer from another institution, with the limitations set forth in the more detailed *Bulletin of Duke University: Graduate School*, (3) in any language for which GSFLT tests are not available, by a reading examination administered by a qualified examiner and arranged by the Graduate School office, or (4) by a reading examination in any foreign language, administered by a qualified member of the faculty under a procedure specified by the department and approved by the Dean and the Executive Committee of the Graduate Faculty.

Advanced level, noncredit, reading courses in French and German are provided for students who need them.

Foreign students whose native language is not English may, with the approval of the Director of Graduate Studies in their major department, substitute English for a foreign language required by their department for a master's or doctoral program.

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*Students interested in additional information on departmental programs not furnished in the *Bulletin of Duke University: Graduate School* should contact the Director of Graduate Studies in the appropriate department.

Other Requirements

The general requirement for a master's degree is a minimum of 30 units (semester hours) of course-seminar-research credit. The student must present acceptable grades for a minimum of 24 units of graduate courses. The nature of the additional 6 units for which students must register depends on whether they are enrolled in thesis or non-thesis programs; i.e., these last 6 units are earned either with successful submission of the thesis or with such other courses or academic exercises as are approved by the student's department.

A master's program can be completed in one academic year, but the student who presents a thesis usually needs at least a calendar year, and foreign students should be prepared to study for two years. The maximum length of time permitted from first registration to completion of all requirements is six years. Under certain circumstances a maximum credit of 6 units may be transferred toward the master's degree for graduate courses completed elsewhere, provided the grades earned in the particular courses were not less than *B* or the equivalent. In such a case, however, the transfer of graduate credit does not reduce the required minimum registration for a master's degree at Duke.

The course-seminar-research requirement in the doctoral program is 60 units, but the proportions of course-seminar work and research are generally flexible, based on individual needs. Those applicants with master's degrees, after establishing quality work here, may be granted transfer credit up to a maximum of 15 units. The dissertation is expected to be a mature and competent piece of writing, embodying the results of original and significant research. All dissertations will be published on microfilm and the author may retain copyright privileges.

Time limitations are set for the completion of the doctoral program. The preliminary examination, which may be taken only after language, course-seminar, and residence requirements have been met, formally admits a student to candidacy for the degree. This examination should be passed by the end of the third year of doctoral study. The interval between preliminary examination and presentation of an acceptable dissertation should ordinarily be one to two years and may not be more than four years without special approval by the Dean. Should this interval extend beyond five years, a second preliminary examination usually becomes necessary.

Financial Information*

Tuition and fees are charged at the rate of $287 per unit (a unit is equivalent to a semester hour), with the normal full program of study being 24 units for an academic year. The basic necessary expenses for a year of graduate study, assuming one lives in University graduate housing, are approximately as follows:

Registration Fee	$ 300
Tuition	6,888
Health Fee	214
Room Rent†	
(Central Campus Apartments)	2,896
Meals‡	2,085

†Depending upon accommodations chosen.
‡Cafeteria estimate.

Normally, a doctoral student will not pay tuition beyond 60 units of degree credit.

Additional allowances should be made for books, laundry, and other personal expenditures.

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*The figures contained in this section are subject to change prior to the beginning of the fall, 1987, semester.

Apartment accommodations for graduate and professional students are available in the Central Campus Apartments, the Town House Apartments, and modular homes, all of which are conveniently located close to East and West Campus. Two- and three-bedroom apartments are available furnished or unfurnished. In addition to University housing, the Central Campus office maintains an off-campus listing service which provides a list of privately owned homes, apartments, duplexes, and efficiencies for rent in Durham.

Duke University does not have a deferred payment plan for tuition, fees, and other charges. Students are expected to pay tuition and fees at the time of matriculation unless they plan to pay via payroll deduction from payments received for fellowships, assistantships, or employment. Graduate students who receive payments from the University and who plan to pay tuition and fees and/or campus housing charges via payroll deduction must make arrangements in the Bursar's office for such deduction.

Financial Aid. In recent years at Duke about two-thirds of all full-time students have held an award of some type; about one-third of these were aided by Duke funds and the other two-thirds by funds from other sources. Part-time students are not eligible for financial aid from the University.

The student who seeks financial aid from Duke University should be certain that the request for admission and award is filed not later than February 1 of the year in which September admission is sought. (The deadline is January 15 for psychology.) The application for admission, including transcripts of previous college work and letters of evaluation, is processed by the Graduate School and forwarded to the department in which the student wishes to pursue advanced work. The graduate faculty—or admissions committee—in the department reviews all applications and then makes its recommendation to the Dean for announcement in late March. The most outstanding applicants are then offered awards; the next in order of rank are placed on an alternate list for awards. Other students are offered only admission to the Graduate School. Because of multiple applications by students, a fraction of the awards offered by any graduate school are not accepted. Alternates on the award list are immediately notified, and the process continues until the available number of awards has been made.

Awards to entering students at Duke are in the form of fellowships, scholarships, and assistantships. Students holding awards usually are paid in nine equal installments beginning in late September.

James B. Duke Graduate Fellowships are provided through the Duke Endowment. Fellows are chosen from nominations made by the departments. Only outstanding applicants who are seeking the Ph.D. degree are considered. These nominations are made in late February and are judged in a competition which includes candidates from all departments granting the Ph.D. degree. The fellowships provide for payment of tuition for full registration and a stipend of $1,000 per month for twelve months during the duration of the award. The award requires no service beyond that which is required of all students in a given department as a part of their training and is renewable each year upon satisfactory progress toward the degree at a fellowship level of quality. The total value of a James B. Duke Fellowship over the full three years of tenure is over $50,000 at current tuition rates.

Graduate Fellowships range in value to $17,000 for the calendar year and are made on a year-to-year basis. They are awarded upon recommendation by each department. No service is required as a prerequisite for accepting a fellowship, but all fellowship holders are expected to maintain full-time registration.

Special Graduate Fellowships for Minority Students provide for payment of tuition plus a stipend of up to $800 per month for nine months. They are awarded to qualified applicants upon the recommendation of the department.

Graduate Scholarships provide for payment of tuition or partial tuition. Full tuition scholarships are valued at $8,070 for the academic year. Scholarships are awarded upon the recommendation of each department.

Graduate Assistantships range in value to $13,000 for the academic year. Assistants are normally permitted to reduce their registration to 9 units, and residence credit as a full-time student is allowed under these circumstances. Assistantships are most common in the science departments, where the student often provides laboratory assistance to various members of the faculty. Most graduate assistants remain in residence during the summer sessions carrying research or course credit. In this way, the normal progress toward a degree is not impeded by the reduced load during the fall and spring semesters. Departmental research funds are often available to provide financial assistance during the summer.

Other graduate fellowships are available from foundations, industry, or the government. Among those at the University's disposal are: Kearns fellowships in religion, Mellon fellowships and traineeships under a grant from the Office of Education for students in the Canadian Studies Program, and Medieval and Renaissance Studies fellowships. Over 300 other traineeships and assistantships are available in the biological, physical, and social sciences under grants from the National Institutes of Health, National Institutes of Mental Health, National Science Foundation, research agencies in the Department of Defense, and other governmental agencies.

Loans. Students who anticipate the need to supplement their financial resources through loans should contact their state lending agencies or banks which provide loans through the Federally Insured Student Loan Program. Students should contact the Graduate School Financial Aid Office for information concerning obtaining the Guaranteed Student Loan if they have problems establishing residency or locating a lender in their home states.

It is the policy of the Graduate School to provide loans through the University to help students meet their educational expenses. Students with full-time status who meet the federal criteria for need and who have applied for loans from their state agencies are eligible for loans through the University. Loan funds are provided through the Federally Insured Student Loan Program and the Perkins Loan (formerly National Direct Student Loan Program). Generally, loans made from these funds or the state lending agencies bear no interest charge to qualified borrowers while they maintain student status and for a short period thereafter. Interest during the repayment period is at a generally favorable rate. The amount of a loan through Duke for first year graduate students is usually limited to the amount of tuition.

Inquiries concerning loans should indicate the department of intended matriculation and include all pertinent information concerning application to a state agency. These inquiries should be addressed to the Financial Aid Coordinator, Graduate School, Duke University, Durham, North Carolina 27706.

The costs of graduate education are high, but Duke University attempts to allocate its funds so that the superior student is able to finish work for a degree in the normal length of time regardless of personal financial resources. This is a contribution to the community of scholarship which the University is glad to bear.

The applicant who wishes further information on facilities and regulations on course programs not covered in this bulletin is invited to write to the Dean of the Graduate School, or the Director of Graduate Studies in the department of intended study.

Calendar of the Graduate School
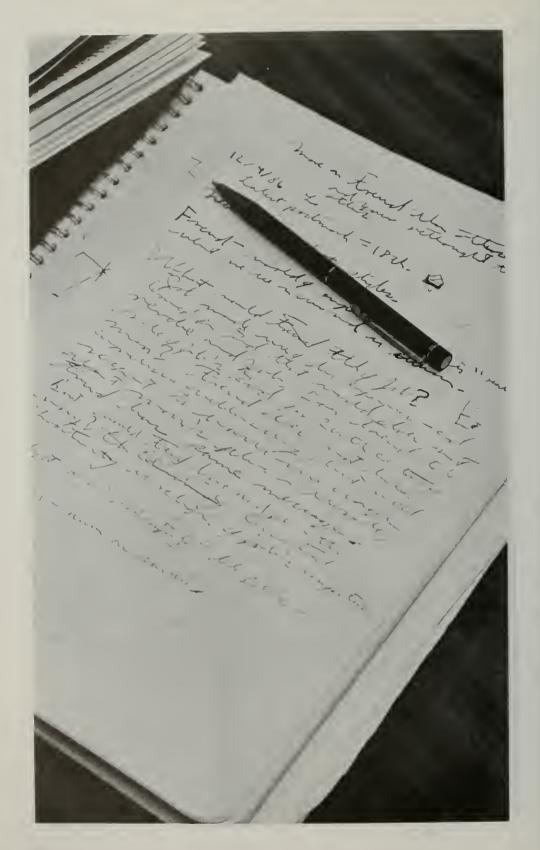
Special Deadlines for Admission Applications

Consult application materials for a more detailed explanation of deadlines.

*For 200-level courses, the length of the reading period is at the discretion of the instructor.
†Students seeking admission to the Graduate School for study in the summer session should apply to the Dean of the Graduate School and to the Director of the Summer Session.

Advanced Degree Programs

Anatomy

Professor J. David Robertson, M.D. (Harvard), Ph.D. (Massachusetts Inst. of Tech.), *James B. Duke Professor of Anatomy* and *Chairman*
Montrose J. Moses, Ph.D. (Columbia), *R. J. Reynolds Industries Professor in Medical Education in the Department of Anatomy* and *Vice Chairman*
Professor Sheila J. Counce, Ph.D. (Univ. of Edinburgh), *Director of Graduate Studies*

Professors

Matt Cartmill, Ph.D. (Chicago); Harold Erickson, Ph.D. (Johns Hopkins); William C. Hall, Ph.D. (Duke); William Hylander, D.D.S. (Illinois at the Medical Center), Ph.D. (Chicago); Richard F. Kay, Ph.D. (Yale); R. Bruce Nicklas, Ph.D. (Columbia); Michael K. Reedy, M.D. (Washington); Elwyn L. Simons, Ph.D. (Princeton), D.Phil. (University Coll., Oxford)

Associate Professors

Joseph M. Corless, M.D., Ph.D. (Duke); Eric L. Effmann, M.D. (Indiana Univ. School of Med.); William Longley, Ph.D. (London); Ross D. E. MacPhee, Ph.D. (Alberta); Thomas J. McIntosh, Ph.D. (Carnegie-Mellon); Lee Tyrey, Ph.D. (Illinois)

Assistant Professors

Nell Cant, Ph.D. (Michigan); M. Joseph Costello III, Ph.D. (Duke); Barbara J. Crain, M.D., Ph.D. (Duke); David Fitzpatrick, Ph.D. (Duke); William E. Garrett, Jr., M.D., Ph.D. (Duke); Emma R. Jakoi, Ph.D. (Duke); Michael K. Lamvik, Ph.D. (Chicago); Chia-Sheng Lin, Ph.D. (Vanderbilt); Patricia M. Saling, Ph.D. (Pennsylvania); Frederick H. Schachat, Ph.D. (Stanford); Kathleen P. Smith, Ph.D. (Harvard)

Professor Emeritus

John W. Everett, Ph.D. (Yale)

Associate Professor Emeritus

Kenneth L. Duke, Ph.D. (Duke)

Associate Medical Research Professor

Kenneth A. Taylor, Ph.D. (California at Berkeley)

Hie Ping Beall, Ph.D. (Tulane); David A. Kopf, Ph.D. (Chicago); Denis Raczkowski, Ph.D. (Duke); Laura F. Schweitzer, Ph.D. (Washington)

Lecturer

Irving T. Diamond, Ph.D. (Chicago)

The Department of Anatomy offers graduate work leading to the Ph.D. degree. A common focus on the interrelations of biological structure and function characterizes the research of the anatomy faculty, although three general departmental subdivisions are recognized: biophysical, cellular, and molecular biology; neurobiology; and physical anthropology, functional morphology, and primate evolution.

The department offers doctoral training programs designed to produce teachers and research scientists competent in a broad range of the anatomical sciences, and students with a wide variety of backgrounds and interests in the biological sciences can be accommodated within the Ph.D. program. A reading knowledge of one foreign language is required of all doctoral students in anatomy. All students participate in the core anatomical science courses (Anatomy 305, 307, 309) and gain experience in teaching over the range of departmental interests. The anatomy department is also a participating member of several interdisciplinary training programs, such as those in genetics, cell and molecular biology, neurobiology, pharmacology, and biological systems. All students are encouraged to round out their training by drawing upon anatomy courses as well as those offered by other departments in the University. Laboratories within the department are equipped for and actively support research in several areas. For further information contact the Director of Graduate Studies.

Courses of Instruction

216S. Biological Psychology
217. Structure and Function of Visual Photoreceptors
219. Molecular and Cellular Bases of Differentiation
220. Developmental Biology
246S. The Primate Fossil Record
259. Molecular Biology I: Protein and Membrane Structure/Function
266S. Comparative Neurobiology
269. Advanced Cell Biology
286. Electron Microscopy and Related Techniques
292. Topics in Morphology and Evolution
301. Anatomy of the Limbs
305. Gross Human Anatomy
307. Microscopic Anatomy

309. Neuroanatomy
310. Frontiers in Neurobiology
312. Research
313, 314. Anatomy Seminar
340. Tutorial in Advanced Anatomy
354. Research Techniques in Anatomy
370. Neurobiology I
418. Reproductive Biology
424. Seminar in Reproductive Biology

Courses Currently Unscheduled

219S. Seminar
238. Functional and Evolutionary Morphology of Primates
288S. The Cell in Development and Heredity
302. Advanced Topics and Research Seminar in Smooth and Striated Muscle

Anthropology

Professor Richard G. Fox, Ph.D. (Michigan), *Chairman*
Assistant Professor Robert P. Weller, Ph.D. (Johns Hopkins), *Director of Graduate Studies*

Professors

Matt Cartmill, Ph.D. (Chicago); William O'Barr, Ph.D. (Northwestern); Elwyn L. Simons, Ph.D. (Princeton), D.Phil. (University Coll., Oxford), *James B. Duke Professor of Anthropology*

Associate Professors

Mahadev L. Apte, Ph.D. (Wisconsin); Kenneth E. Glander, Ph.D. (Chicago); William Hylander, Ph.D. (Chicago); Naomi Quinn, Ph.D. (Stanford); Carol A. Smith, Ph.D. (Stanford)

Assistant Professors

Virginia R. Domínguez, Ph.D. (Yale); Michel-Rolph Trouillot, Ph.D. (Johns Hopkins); Allen Zagarell, Ph.D. (Freie Univ., West Berlin)

The department offers graduate work leading to the Ph.D. degree in anthropology. Applicants for admission should submit scores on the Graduate Record Examination Aptitude Test. Admission to the program is not contingent on previous anthropological course work or any other specific program of study at the undergraduate level.

The department offers a program of specialization in social/cultural anthropology and a program of specialization in physical anthropology. The emphasis of the social/cultural anthropology program is the application of a theoretical and comparative perspective to research in complex societies. Within this perspective, a wide range of interests is represented in the department. The emphasis of the physical anthropology program is primate evolution; areas of concentration include comparative morphology of human and nonhuman primates and primate social behavior.

Curriculum is tailored to the individual student's background, academic needs, and research goals; pursuit of relevant cross-disciplinary study, within and outside the department, is expected. However, a modest number of courses is required of students in both programs. Candidates for the Ph.D. degree must demonstrate competence in their chosen subfield of specialization and knowledge of the broad theoretical perspectives, from all relevant disciplines, which inform their area of concentration.

Further details of the graduate program in anthropology, the departmental facilities, the staff, and various stipends available are described in the *Guidelines for Graduate Students in Anthropology* which may be obtained from the Director of Graduate Studies.

Courses of Instruction

201S. Marxism and Anthropology
204S. The Anthropology of Cities
206S. Current Theoretical Schools in Anthropology
211S. Ethnography of Communication
215S. The Anthropology of Women: Theoretical Issues
220S. The Cultural Construction of Gender
228S. Slavery and Society
234S. Political Economy of Development: Theories of Change in the Third World
239. Culture and Ideology
241. The Rise of Civilization in Mesopotamia and Iran
243S. Theory and Method in Archaeology
244S. Primate Behavior
246S. The Primate Fossil Record
251S. American Marriage: A Cultural Approach
255S. Heroes and Heroics: Culture and the Individual
258S. Symbols in Society
267. Cognitive Anthropology
272S. Marxism and Feminism
280S, 281S. Seminar in Selected Topics
282S. Canada
330S, 331S. Theories in Sociocultural Anthropology
393. Individual Research in Anthropology

Courses Currently Unscheduled

205. The Anthropology of Anthropology
237S. Interpretations of Kinship
275S. Inequality in Precapitalist Societies
334. Topics in Physical Anthropology

Art and Art History

Associate Professor Rona Goffen, Ph.D. (Columbia), *Director of Graduate Studies*

Assistant Professors

David Castriota, Ph.D. (Columbia); Elizabeth G. Higdon, Ph.D. (Bryn Mawr); Judy Sund, Ph.D. (Duke)

Professor Emeritus

Sidney David Markman, Ph.D. (Columbia)

Graduate work in the Department of Art and Art History is offered leading to the A.M. degree in art history and is designed to provide basic training in the history of art with specialization in a given field selected by the student after consultation with and approval by the Director of Graduate Studies. Prospective students should present a minimum of 24 semester hours of undergraduate work in the history of art. In special cases a student who does not fulfill this prerequisite may be required to attend prescribed undergraduate courses. A reading knowledge of one foreign language (preferably German) is required; candidates who do not meet this requirement upon admission to the program are expected to do so by the end of their first term in residence.

The program for the A.M. degree in art history consists of 30 units as follows: 12 units in art history; 6 units in an approved minor; 6 units in the major or minor, or other approved subject; and 6 units in thesis. A written thesis is required.

Courses of Instruction

230S. Medieval and Byzantine Art and Architecture
232S. Romanesque and Gothic Art and Architecture
234. Medieval Architecture
235. Gothic Cathedrals
241. Fifteenth-Century Italian Art
242S. Studies in Italian Renaissance Art
243S. Studies in Northern Art
251. Italian Baroque Art
252. Northern Baroque Painting
261S. Studies in Romanticism
262S. Studies in Nineteenth-Century Art
274. The History of Impressionism
275. Surrealism

276S. Problems in Modern Art
278. Twentieth-Century Criticism
293S. Methods in Art History
294, 295. Special Problems in Art History

Courses Currently Unscheduled

220S. Greek Painting
227. Early Christian Culture: Evidence of Art and Literature
231. Byzantine Art and Architecture
240. Italian Art
245. Sixteenth-Century Italian Art
277S. Contemporary Art
279S. Problems in Modern Architecture

Asian Languages

The courses are offered as an enrichment for students interested in the South Asian subcontinent. See the announcement for the Asian-Pacific Studies Institute in this bulletin in the section on special programs. For courses in Chinese and Japanese, see the *Bulletin of Duke University: Undergraduate Instruction*.

Courses Currently Unscheduled

Hindi-Urdu 200, 201. Special Studies in South Asian Languages
Hindi-Urdu 203. Studies in Commonwealth Literature

Biochemistry

Professor Robert L. Hill, Ph.D. (Kansas), *James B. Duke Professor of Biochemistry* and *Chairman*
Professor Robert E. Webster, Ph.D. (Duke), *Director of Graduate Studies*

Professors

Robert Bell, Ph.D. (California at Berkeley); Irwin Fridovich, Ph.D. (Duke), *James B. Duke Professor of Biochemistry*; Samson R. Gross, Ph.D. (Columbia); Walter R. Guild, Ph.D. (Yale); Henry Kamin, Ph.D. (Duke); Nicholas M. Kredich, M.D. (Michigan); Robert J. Lefkowitz, M.D. (Columbia); Kenneth S. McCarty, Ph.D. (Columbia); Paul L. Modrich, Ph.D. (Stanford); K. V. Rajagopalan, Ph.D. (Univ. of Madras); Lewis M. Siegel, Ph.D. (Johns Hopkins); Leonard Spicer, Ph.D. (Yale)

Ronald C. Greene, Ph.D. (California Inst. of Tech.); Arno L. Greenleaf, Ph.D. (Harvard); Tao-shih Hsieh, Ph.D. (California at Berkeley); Bernard Kaufman, Ph.D. (Indiana); David C. Richardson, Ph.D. (Massachusetts Inst. of Tech.); Harvey J. Sage, Ph.D. (Yale); Deborah A. Steege, Ph.D. (Yale); James B. Sullivan, Ph.D. (Texas)

Assistant Professors

Michael S. Hershfield, M.D. (Pennsylvania); Russel E. Kaufman, M.D. (Ohio State University)

Professor Emeritus

Mary L. C. Bernheim, Ph.D. (Univ. of Cambridge)

Associate Medical Research Professor

Jane Richardson, M.A.T. (Harvard)

Graduate work in the Department of Biochemistry is offered leading to the Ph.D. degree. Preparation for such graduate study may take diverse forms. Undergraduate majors in chemistry, biology, mathematics, or physics are welcome, but adequate preparation in chemistry is essential. Graduate specialization areas include protein structure and function, crystallography of macromolecules, nucleic acid structure and function, lipid biochemistry, membrane structure and function, molecular genetics, enzyme mechanisms, and neurochemistry. The Division of Genetics of the department, in cooperation with the University Program in Genetics, offers biochemistry students the opportunity to pursue advanced research and study to fulfill the requirements for the Ph.D. degree.

Courses of Instruction

200. General Biochemistry
209-210. Independent Study
215. Genetic Mechanisms
219. Molecular and Cellular Bases of Differentiation
219S. Seminar
220L. Adaptations of Organisms to the Marine Environment
220S. Adaptations of Organisms to the Marine Environment
222. Structure of Biological Macromolecules
224. Biochemistry of Development and Differentiation
227. Introductory Biochemistry I: Intermediary Metabolism

245L. Macromolecules, Ecology, and Evolution
259. Molecular Biology I: Protein and Membrane Structure/Function
265S, 266S. Seminar
268. Molecular Biology II: Nucleic Acids
276. Comparative and Evolutionary Biochemistry
286. Current Topics in Immunochemistry
288. The Carbohydrates and Lipids of Biological Systems
291. Physical Biochemistry
296. Biological Oxidations
297. Intermediary Metabolism
299. Nutrition
345, 346. Biochemistry Seminar
347, 348. Seminar in Toxicology

Botany

Professor William Lewis Culberson, Ph.D. (Wisconsin), *Hugo L. Blomquist Professor of Botany* and *Chairman*
Professor John E. Boynton, Ph.D. (California at Davis), *Director of Graduate Studies*

Professors

Janis Antonovics, Ph.D. (Univ. Coll. of North Wales), *James J. Wolfe Professor of Botany*; Richard T. Barber, Ph.D. (Stanford); Norman L. Christensen, Jr., Ph.D. (California at Santa Barbara); C. Barry Osmond, Ph.D. (Univ. of Adelaide), *Arts and Sciences Professor of Botany*; Richard B. Searles, Ph.D. (California at Berkeley); James N. Siedow, Ph.D. (Indiana); Donald E. Stone, Ph.D. (California at Berkeley); Boyd R. Strain, Ph.D. (California at Los Angeles); Richard A. White, Ph.D. (Michigan); Robert L. Wilbur, Ph.D. (Michigan)

Associate Professors

Kenneth R. Knoerr, Ph.D. (Yale); Joseph S. Ramus, Ph.D. (California at Berkeley); William H. Schlesinger, Ph.D. (Cornell)

Assistant Professors

Stephen A. Johnston, Ph.D. (Wisconsin); Bruce D. Kohorn, Ph.D. (Yale); Brent Drennen Mishler, Ph.D. (Harvard); Rytas Vilgalys, Ph.D. (Virginia Polytechnic and State Univ.)

Professors Emeriti

Lewis Edward Anderson, Ph.D. (Pennsylvania); William D. Billings, Ph.D. (Duke), *James B. Duke Professor Emeritus of Botany*; Henry Hellmers, Ph.D. (California at Berkeley); Paul J. Kramer, Ph.D. (Ohio State), *James B. Duke Professor Emeritus of Botany*; Aubrey Willard Naylor, Ph.D. (Chicago), *James B. Duke Professor Emeritus of Botany*; Jane Philpott, Ph.D. (Iowa)

Adjunct Professor

Chicita F. Culberson, Ph.D. (Duke)

Adjunct Associate Professor

David T. Patterson, Ph.D. (Duke)

Graduate work in the Department of Botany is offered leading to the A.M. (non-thesis), M.S. (thesis), and Ph.D. degrees. Students entering the graduate program in Botany normally have a broad background in the botanical or biological sciences supplemented with basic courses in chemistry, mathematics, and physics. Biochemistry and physical chemistry are strongly recommended for students interested in molecular areas, and advanced courses in mathematics are recommended for students in population genetics and ecology. Deficiencies may be corrected by taking appropriate courses during the first year of graduate study.

Students in Botany may specialize in a wide variety of areas including anatomy; cellular and molecular biology; evolution; developmental, ecological, molecular, organelle, and population genetics; physiology; community, ecosystem, physiological, and population ecology; marine biology; and the systematics of algae, fungi, lichens, bryophytes, ferns, and flowering plants. Students' programs are tailored to individual needs. A brochure providing detailed information on the Botany Department is available from the Director of Graduate Studies.

Courses of Instruction

205. Genetic Engineering
209L. Lichenology
210L. Bryology
212L. Phycology
215L. Primary Productivity in the Seas
218. Barrier Island Ecology
221L. Mycology
222S. Topics in Advanced Mycology
225T, 226T. Special Problems
227. Introductory Biochemistry I: Intermediary Metabolism
232. Microclimatology
234S. Problems in the Philosophy of Biology
237L. Systematic Biology
242L. Systematics
243S. Classification of Angiosperms
245L. Plant Diversity
246L. Ecology of Plants
250L,S. Plant Biosystematics
251L. Plant Physiology
253. Biophysical Plant Physiology
261. Photosynthesis
265L. Physiological Plant Ecology
266. Plant Population Biology
267L. Community Ecology

268. Molecular Biology II: Nucleic Acids
269. Advanced Cell Biology
272. Biogeochemistry
280. Principles of Genetics
283. Extrachromosomal Inheritance
285S. Ecological Genetics
286. Evolutionary Mechanisms
287S. Macroevolution
293L. Population Biology
295S, 296S. Seminar
300. Tropical Biology: An Ecological Approach
330L. Environmental Monitoring and Instrumentation
359, 360. Research in Botany

Courses Currently Unscheduled

219L. Benthic Marine Algae
247L. Plant Ecology
258. Physiology of Growth and Development
260L. Plant Anatomy
263L. Tropical Seaweeds
344. Micrometeorology and Biometeorology Seminar

Related Programs

The University Program in Cell and Molecular Biology. Cell and Molecular Biology courses offered by the Botany Department are an integral part of this interdepartmental program. Refer to the announcement in this bulletin under The University Program in Cell and Molecular Biology.

University Program in Genetics. Genetics courses offered by the botany department are an integral part of this interdepartmental program. Refer to the announcement in this bulletin under The University Program in Genetics.

Program in Tropical Biology. Fellowships are available for travel and subsistence in field-oriented programs in Central America. Refer to Organization for Tropical Studies in the section on special programs.

The University Program in Marine Sciences. Interdisciplinary programs emphasizing marine botany are available. Refer to the announcement in this bulletin under The University Program in Marine Sciences.

Business Administration

Professor Thomas F. Keller, Ph.D. (Michigan), *R. J. Reynolds Industries Professor of Business Administration* and *Dean*
Professor James R. Bettman, Ph.D. (Yale), *Burlington Industries Professor of Business Administration* and *Director of Graduate Studies*

Professors

Robert Ashton, Ph.D. (Minnesota); Helmy Baligh, Ph.D. (California at Berkeley); Richard M. Burton, D.B.A. (Illinois); Kalman J. Cohen, Ph.D. (Carnegie-Mellon); John D. Forsyth, D.B.A. (Illinois); Dan J. Laughhunn, D.B.A. (Illinois); Arie Y. Lewin, Ph.D. (Carnegie-Mellon); Richard C. Morey, Ph.D. (California at Berkeley); Thomas H. Naylor, Ph.D. (Tulane); John W. Payne, Ph.D. (California at Irvine); Richard Staelin, Ph.D. (Michigan), *Edward and Rose Donnell Professor of Business Administration*; Robert L. Winkler, Ph.D. (Chicago)

Associate Professors

Allison Ashton, Ph.D. (Texas); Joseph Battle, Ph.D. (Michigan); Douglas T. Breeden, Ph.D. (Stanford); Joel C. Huber, Ph.D. (Pennsylvania); John M. McCann, Ph.D. (Purdue); Wesley A. Magat, Ph.D. (Northwestern); Joseph B. Mazzola, Ph.D. (Carnegie-Mellon); William E. Ricks, Ph.D. (California at Berkeley); Blair H. Sheppard, Ph.D. (Illinois at Champaign); James W. Vaupel, Ph.D. (Harvard); Robert E. Whaley, Ph.D. (Toronto)

Assistant Professors

William F. Boulding, Ph.D. (Pennsylvania); Marian Burke, Ph.D. (California at Los Angeles); Jane L. Butt, Ph.D. (Michigan); Richard L. Daniels, Ph.D. (California at Los Angeles); Julie A. Edell, Ph.D. (Carnegie-Mellon); F. Douglas Foster, Ph.D. (Cornell); Grant W. Gardner, Ph.D. (Harvard); Campbell R. Harvey, Ph.D. (University of Chicago); Kirk R. Karwan, Ph.D. (Carnegie-Mellon); Frederick Lindahl, Ph.D. (University of Chicago); Kevin F. McCardle, Ph.D. (California at Los Angeles); Michael J. Moore, Ph.D. (Michigan); Robert F. Nau, Ph.D. (California at Berkeley); Donna Rae Philbrick, Ph.D. (Cornell); Elaine Romanelli, Ph.D. (Columbia); Jeffrey L. Rummel, Ph.D. (Rochester); Jens A. Stephan, Ph.D. (Cornell); Anne S. Tsui, Ph.D. (California at Los Angeles); S. Viswanathan, Ph.D. (Northwestern)

Adjunct Professor

David West Peterson, Ph.D. (Stanford)

The Ph.D. in Business Administration program prepares candidates for research and teaching careers at leading educational institutions and for careers in business and governmental organizations where advanced research and analytical capabilities are required. The Ph.D. program places major emphasis on independent inquiry, on the development of competence in research methodology, and on the communication of research results.

The program requires that doctoral candidates must acquire expertise in three disciplines: economics, behavioral science, and quantitative methods. In addition, each candidate must acquire knowledge at the M.B.A. level of at least three of

the following functional areas: accounting, finance, marketing, and operations management. Competence in the three disciplines and the functional areas may be gained from the student's choice of course work, participation in seminars, and independent study. Each student takes a comprehensive examination at the end of the second year or at the beginning of the third year of residence. The final requirement is the presentation of a dissertation. The Ph.D. program usually requires three to four years of work beyond the bachelor's degree.

Refer to the *Bulletin of Duke University: The Fuqua School of Business* for a complete list of courses and course descriptions.

Courses of Instruction

510. Bayesian Inference and Decision
521. Organization Seminar: A Micro Focus
522. Organization Seminar: A Macro Focus
531. Financial Accounting Seminar
532. Management Accounting Seminar
551. Corporate Finance Seminar
552. Investment Seminar
561. Seminar in Quantitative Research in Marketing
562. Seminar in Behavioral Models in Marketing
571. Operations Strategy Seminar
572. Seminar in Operational and Technological Tactics
597. Dissertation Research
598. Independent Study
599. Directed Research

Courses Currently Unscheduled

309.1-.9. Research in Managerial Economics
319.1-.9. Research in Quantitative Methods
329.1-.9. Research in Organization Theory and Management
339.1-.9. Research in Information and Accounting Systems
349.1-.9. Research in Public Policy and Social Responsibility
359.1-.9. Research in Finance
369.1-.9. Research in Marketing
379.1-.9. Research in Production
392-393. Tutorial in Interdisciplinary Areas
397. Dissertation Research

The University Program in Cell and Molecular Biology

Professor Robert L. Hill, Ph.D. (Kansas), *James B. Duke Professor of Biochemistry* and *Director*
Associate Professor Bernard Kaufman, Ph.D. (Indiana), *Associate Director*

Professors

Harold Erickson, Ph.D. (Johns Hopkins); David R. McClay, Ph.D. (North Carolina at Chapel Hill); Paul L. Modrich, Ph.D. (Stanford); R. Bruce Nicklas, Ph.D. (Columbia); Salvatore V. Pizzo, M.D., Ph.D. (Duke); Thomas C. Vanaman, Ph.D. (Duke)

Associate Professors

Jack D. Keene, Ph.D. (Washington); James N. Siedow, Ph.D. (Indiana)

Assistant Professor

Marc G. Caron, Ph.D. (University of Miami)

Faculty: A complete list of faculty, including research interests, will be made available to prospective students.

Research training in cell, developmental, and molecular biology is found in eight departments at Duke University: anatomy, biochemistry, botany, microbiology and immunology, pathology, pharmacology, physiology, and zoology. To effectively utilize this broad spectrum of expertise for the training of promising, young scientists while still providing a coherent curriculum, the Duke University Program in Cell and Molecular Biology has been established.

During the first year of doctoral study a student will complete the program's three-course sequence presenting current understanding and research activities in cell biology and the molecular biology of nucleic acids, proteins, and membranes. Each student will also affiliate with a department, fulfill departmental requirements, and choose elective courses in an area of specialization. Research training is stressed throughout the program

and dissertation research usually begins by the third semester. Normally the dissertation adviser will be chosen from within the student's own department but, depending on the student's research interests, dissertation research with an adviser in another department may be approved.

Prospective students may apply directly to the Cell and Molecular Biology Program or to one of the eight participating departments. Those who apply to the program must also designate a departmental preference. Applicants must have demonstrated, in addition to overall academic excellence, a proficiency in the biological and physical sciences. Applications for admission and fellowship support must be received by February 1, but early applications may receive earlier consideration.

Courses of Instruction

259. Molecular Biology 1: Protein and Membrane Structure/Function
264. Cell and Molecular Biology Seminar

268. Molecular Biology II: Nucleic Acids
269. Advanced Cell Biology

Chemistry

Professor Charles H. Lochmüller, Ph.D. (Fordham), *Chairman*
Associate Professor Steven Baldwin, Ph.D. (California Inst. of Tech.), *Director of Graduate Studies*

Professors

Edward M. Arnett, Ph.D. (Pennsylvania), *R. J. Reynolds Industries Professor of Chemistry*; Donald B. Chesnut, Ph.D. (California Inst. of Tech.); Alvin L. Crumbliss, Ph.D. (Northwestern); Bertram O. Fraser-Reid, Ph.D. (Alberta), *James B. Duke Professor of Chemistry*; Peter W. Jeffs, Ph.D. (Univ. of Natal); William R. Krigbaum, Ph.D. (Illinois), *James B. Duke Professor of Chemistry*; Andrew T. McPhail, Ph.D. (Univ. of Glasgow); Richard A. Palmer, Ph.D. (Illinois); Jacques C. Poirier, Ph.D. (Chicago); Ned Allen Porter, Ph.D. (Harvard), *James B. Duke Professor of Chemistry*; Peter Smith, Ph.D. (Univ. of Cambridge); Howard Austin Strobel, Ph.D. (Brown); Richard L. Wells, Ph.D. (Indiana); Pelham Wilder, Jr., Ph.D. (Harvard)

Associate Professors

Robert W. Henkens, Ph.D. (Yale); Barbara Ramsay Shaw, Ph.D. (Univ. of Washington)

Assistant Professors

Richard A. MacPhail, Ph.D. (California at Berkeley); Richard P. Polniaszek, Ph.D. (UCLA)

Professor Emeritus

Louis DuBose Quin, Ph.D. (North Carolina at Chapel Hill), *James B. Duke Professor of Chemistry*

Adjunct Professors

Robert G. Ghirardelli, Ph.D. (California Inst. of Tech.); Colin G. Pitt, Ph.D. (Univ. of London); Bernard Spielvogel, Ph.D. (Michigan)

Adjunct Assistant Professor

Mary Ellen Switzer, Ph.D. (Illinois)

In the Department of Chemistry graduate work is offered leading to the M.S. and Ph.D. degrees. Before undertaking a graduate program in chemistry, a student should have taken an undergraduate major in chemistry, along with related work in mathematics and physics.

Graduate courses in the department are offered in the fields of analytical, inorganic, organic, and physical chemistry. Research programs are active in all these fields.

A booklet providing detailed information on the department is available from the Director of Graduate Studies.

Courses of Instruction

201. Molecular Spectroscopy
203. Quantum Chemistry
205. Structure and Reaction Dynamics
207. Principles of Kinetics, Thermodynamics, and Diffraction
275, 276. Advanced Studies
300. Basic Statistical Mechanics
302. Basic Quantum Mechanics
303, 304. Special Topics in Physical Chemistry
310. Theoretical and Structural Inorganic Chemistry
312. Inorganic Reactions and Mechanisms
313. Special Topics in Inorganic Chemistry
320. Synthetic Organic Chemistry
322. Organic Reactive Intermediates
324. Special Topics in Organic Chemistry
330. Separation Science and Fundamental Electrochemistry
331, 332. Special Topics in Analytical Chemistry
334. Chemical Instrumentation and Practical Electrochemistry
373, 374. Seminar
375, 376. Research
377. Research Orientation Seminar

Classical Studies

Professor C. John Herington, M.A. (Oxford and Yale), *Arts and Sciences Professor of Classical Studies* and *Chairman*
Associate Professor John G. Younger, Ph.D. (Cincinnati), *Director of Graduate Studies*

Professors

Francis Newton, Ph.D. (North Carolina at Chapel Hill); John F. Oates, Ph.D. (Yale); Lawrence Richardson, Jr., Ph.D. (Yale)

Associate Professors

Mary T. Boatwright, Ph.D. (Michigan); Peter Burian, Ph.D. (Princeton); Kent J. Rigsby, Society of Fellows (Harvard); Dennis Keith Stanley, Jr., Ph.D. (Johns Hopkins)

Professor Emeritus

William H. Willis, Ph.D. (Yale)

Visiting Professor

Agnes K. Michels, Ph.D. (Bryn Mawr)

The Department of Classical Studies offers graduate work leading to the A.M. and Ph.D. degrees. For regular admission, students should offer three years of college study in one of the classical languages and two college years in the other; courses in ancient history and in classical art and archaeology are strongly recommended. Upon matriculation all students take a diagnostic examination in Greek and Latin to determine the appropriate language and literature courses for further study. A reading knowledge of two modern languages, German and French, is required of all candidates for the Ph.D.; the candidate should meet one of the language requirements by the end of the first term in residence and the other by the end of the third term. Before beginning the dissertation, the typical student will have taken at least six courses in Greek, six in Latin, five in history, and two in art and archaeology, and a qualifying examination in both Greek and Latin literature based upon the department's reading list. Students then take the following preliminary examinations: in the general area of concentration (e.g., art and archaeology, Greek and Latin literature, or ancient history), in the student's special area of concentration, and in a subject unrelated to the student's proposed dissertation. The department maintains one of the country's major collections of Greek and Latin manuscripts and papyri, extensive computer facilities in Latin and in Mycenaean, Classical, and modern Greek, and an excellent study collection of Greek and Roman art. The Director of Graduate Studies will provide on request the reading list and a brochure detailing further information about the department's special requirements, dissertation writing, and financial aid; prospective students should also consult the general requirements of the University set forth in the section on "General Regulations Governing Graduate Studies" in this bulletin.

Greek

Courses of Instruction

200. Intensive Survey of Greek Literature I
201. Intensive Survey of Greek Literature II
203. Homer
222. The Historians
301. Seminar in Greek Literature I
302. Seminar in Greek Literature II
399. Directed Reading and Research

Courses Currently Unscheduled

205. Greek Lyric Poets
207. The Dramatists
221. Early Greek Prose
226. The Orators
313. Proseminar in Greek Epigraphy
321. Seminar in Literary Papyri

Latin

Courses of Instruction

200. Intensive Survey of Latin Literature I
201. Intensive Survey of Latin Literature II
205. The Roman Novel
206. Cicero
214. The Historians
301. Seminar in Latin Literature I
302. Seminar in Latin Literature II
399. Directed Reading and Research

Courses Currently Unscheduled

204. Epic of the Silver Age: Lucan to Statius
207. Vergil's *Aeneid*
208. Lyric and Occasional Poetry
211. Elegiac Poets
221. Medieval Latin
312. Proseminar in Latin Paleography
314. Proseminar in Latin Epigraphy
315. Proseminar in Roman Law

Classical Studies (Ancient History)

Courses of Instruction

221. Archaic Greece
226. Late Antiquity
258. Social and Cultural History of the Graeco-Roman World
321. Seminar in Ancient History I
322. Seminar in Ancient History II
399. Directed Reading and Research

Courses Currently Unscheduled

222. Fifth and Fourth Century Greece
223. Alexander and the Hellenistic World
224. The Roman Republic
225. The Roman Empire
327. Seminar in Byzantine History

Classical Studies (Archaeology)

Courses of Instruction

231S. Greek Sculpture
232S. Greek Painting
311. Archaeology Seminar I
312. Archaeology Seminar II
399. Directed Reading and Research

Courses Currently Unscheduled

233S. Greek Architecture
234S. Roman Sculpture
235S. Roman Architecture
236S. Roman Painting

Under the terms of a cooperative agreement, graduate students of Duke University may take appropriate graduate courses offered by the Departments of Classics or Art of the University of North Carolina. A list of these courses will be sent upon request.

Computer Science

Professor Donald Rose, Ph.D (Harvard), *Chairman*
Assistant Professor Daniel B. Szyld, Ph.D. (New York Univ.), *Director of Graduate Studies*

Professors

Alan W. Biermann, Ph.D. (California at Berkeley); Thomas M. Gallie, Ph.D (Rice); Donald W. Loveland, Ph.D. (New York Univ.); Peter N. Marinos, PhD. (North Carolina State); Merrell L. Patrick, Ph.D. (Carnegie-Mellon); John H. Reif, Ph.D. (Harvard); Arnold L. Rosenberg. PhD. (Harvard); Charles Starmer, Ph.D. (North Carolina at Chapel Hill); Kishor S. Trivedi, Ph.D. (Illinois); Senol Utku. Sc.D. (Massachesetts Inst. of Tech.); Max A Woodbury, Ph.D. (Michigan)

Associate Professors

Bruce W. Ballard, Ph.D. (Duke); Carla S. Ellis, Ph.D. (Washington); Henry S. Greenside, Ph.D. (Princeton); Gershon Kedem, Ph.D. (Wisconsin); Robert A. Wagner, Ph.D. (Carneigie-Mellon)

The Department of Computer Science offers programs leading to the M.S. and Ph.D. degrees. The department also actively cooperates with the computer science department of the University of North Carolina at Chapel Hill.

A student entering graduate work in computer science should have had three semesters of calculus and one semester of linear algebra, and have a knowledge of data structures, and of assembler as well as higher-level computer programming languages. Research interests of present faculty include mathematical foundations of methodology, real-time computing, operating data base systems, computer systems design and analysis, parallel processing systems, scientific computation (including numerical analysis), and very large-scale integration.

Courses of Instruction

200. Programming Methodology I
201. Programming Lauguages
202. Applied Discrete Structures
204. Computer Network Architecture
207. Fault-Tolerant Computer Systems
208. Digital Computer Design
209. Microprocessor Fundamentals and Applications
210. VLSI Systems: an Introduction
212. Introduction to Scientific Computing
215. Artifical Intelligence
221. Numerical Analysis I
222. Numerical Differential Equations
223. Numerical Linear Algebra
224. Analysis of Algorithms
225. Formal Languages and Theory of Computation
226. Mathematical Methods for Systems Analysis I
227. Mathematical Mehtods for Systems Analysis II
231. Introduction to Operating Systems
232. Compiler Construction
241. Data Base Methodology
252. Computer Systems Organization
265. Advanced Topics in Computer Science
276. Communication, Computation, and Memory in Biological Systems

308. Advanced Topics in Digital Systems
310. CMOS VLSI Design
315. Advanced Topics in Artifical Intelligence
316. Computational Linguistics
320. VLSI Algorithmics
321. Topics in Numerical Mathematics
326. Systems Modeling
331. Operating Systems Theory
382. Seminar in Artifical Intelligence

Courses Currently Unscheduled

301. Topics in Programming Theory
325. Theory of Computation
332. Topics in Operating Systems

Supplementary Courses Offered at UNC-CH

Comp 145. Software Engineering Laboratory
Comp 171. Natural Language Processing
Comp 230. File Management Systems
Comp 236. Computer Graphics
Comp 238. Raster Graphics
Comp 254. Picture Processing and Pattern Recognition
Comp 265. Architecture of Computers

Economics

Professor Eliot Roy Weintraub, Ph.D. (Pennsylvania), *Chairman*
Professor Henry Grabowski, Ph.D. (Princeton), *Director of Graduate Studies*

Professors

Charles T. Clotfelter, Ph.D. (Harvard); Philip J. Cook, Ph.D. (California at Berkeley); David G. Davies, Ph.D. (California at Los Angeles); Neil Barry de Marchi, Ph.D. (Australian National Univ.); John F. Geweke, Ph.D. (Minnesota); S. Malcolm Gillis, Ph.D. (Illinois); Craufurd D. Goodwin, Ph.D. (Duke), *James B. Duke Professor of Economics*; Daniel A. Graham, Ph.D. (Duke); Thomas M. Havrilesky, Ph.D. (Illinois); Allen C. Kelley, Ph.D. (Stanford); Anne O. Krueger, Ph.D. (Wisconsin), *Distinguished Professor of Economics*; Marjorie McElroy, Ph.D. (Northwestern); Thomas H. Naylor, Ph.D. (Tulane); Edward Tower, Ph.D. (Harvard); Vladimir G. Treml, Ph.D. (North Carolina at Chapel Hill); John M. Vernon, Ph.D. (Massachusetts Inst. of Tech.); Thomas D. Wallace, Ph.D. (Chicago), *James B. Duke Professor of Economics*; William P. Yohe, Ph.D. (Michigan)

Associate Professors

Kent P. Kimbrough, Ph.D. (Chicago); George E. Tauchen, Ph.D. (Minnesota)

Assistant Professors

James Baumgardner, Ph.D. (Chicago); Philip L. Brock, Ph.D. (Stanford); Robert C. Marshall, Ph.D. (California at San Diego); Michael Meurer, Ph.D. (Minnesota); Sudhir Shetty, Ph.D. (Cornell); Dale O. Stahl II, Ph.D. (California at Berkeley); Gary A. Zarkin, Ph.D. (Chicago)

Research Professors

A. W. Coats, Ph.D. (Johns Hopkins); James Henderson, Ph.D. (Harvard)

Adjunct Professor

Robert H. Bates, Ph.D. (MIT)

The Department of Economics offers graduate work leading to the A.M. and Ph.D. degrees. Among the undergraduate courses of distinct advantage to the graduate student in economics are statistics, economic theory, and basic courses in philosophy, mathematics, and social sciences other than economics. Advanced work in mathematics or statistics is also useful.

Requirements for the Ph.D. degree in economics include courses in economic theory, quantitative methods, and econometrics in the first year, and at the end of the second year, an examination in economic analysis. In addition, a student must obtain certification in three fields, one of which may be in an outside minor. The student may select from advanced economic theory, history of political economy, economic development, economic history, international economics, money and banking, labor economics, public finance, industrial organization, econometrics, statistics, Soviet economics, corporate economics, and certain fields outside the economics department (e.g., demography). Course work for the Ph.D. degree should be completed in five semesters of residence.

Courses of Instruction

200. Capitalism and Socialism
201S, 202S. Current Issues in Economics
204S. Advanced Monetary Economics
205S. Advanced Monetary Theory and Policy
212S. Economic Science and Economic Policy
213S.1. The Economics of Slavery in the American South
214. Social Choice
218. Macroeconomic Policy
219S. Economic Problems of Underdeveloped Areas
232. Analytical Methods IV: Topics in Economic Policy
233. Federal, State, and Local Finance and Economic Policies

234. Urban and Regional Economics
243. Econometrics I
244. Corporate Economics I
245. Econometrics II
246. Selected Topics in Econometric Theory
247S. Applied Econometrics
249. Microeconomics
250S. Modern Economic Thought
254. Macroeconomics
265S. International Trade and Finance
268. Federal Tax Policy
286S. Economic Policy Making in Developing Countries
293. Soviet Economic History
294S. Soviet Economic System

301. Microeconomic Analysis I
302. Microeconomic Analysis II
304, 305. Monetary Theory and Policy
307. Quantitative Analysis I
308. Quantitative Analysis II
311, 312. History of Political Economy
313, 314. Seminar in Economic Theory
317. Seminar in Demographic, Population, and Resource Problems (Development Economics I)
319. Seminar in the Theory and the Problems of Economic Growth and Change (Development Economics II)
320. Macroeconomic Analysis I
322. Macroeconomic Analysis II
323. Income Distribution Theory
324, 325. Economics of the Law
329. Federal Finance
330. Seminar in Public Finance
350. Modern Economic Thought
355. Seminar in Labor Economics
358. Seminar in Labor Market and Related Analysis

359. Economic Analysis of Legal Issues
365. Seminar in International Trade Theory and Policy
366. Seminar in International Monetary Theory
380. Graduate Economics Workshops
388. Industrial Organization
389. Seminar in Industrial and Governmental Problems
397, 398. Directed Research

Courses Currently Unscheduled

235. The Economics of Crime, Law Enforcement, and Justice
285. Evaluation of Public Expenditures
303. Theory of Economic Decision Making
316. Seminar in Economics of Soviet-Type Socialism
321. Theory of Quantitative Economic Policy
331. Seminar in Economic History
345, 346. Demographic Techniques I and II
401. Seminar on the British Commonwealth
402. Interdisciplinary Seminar in the History of the Social Sciences

Related Courses in Other Departments

Courses in related fields may be selected from anthropology, computer science, forestry, history, mathematics, philosophy, political science, public policy studies, and sociology, or from an area that complements the candidate's area of research interests in economics. See also the section on the Center for Demographic Studies under "Special Programs" in this bulletin.

Education

Associate Professor Lucy T. Davis, Ed.D. (Columbia), *Chairman* and *Director of Graduate Studies*

Professor

Ellis B. Page, Ed.D. (California at Los Angeles)

Associate Professors

Robert H. Ballantyne, Ed.D. (Washington State); Peter F. Carbone, Ed.D. (Harvard); Joseph Di Bona, Ph.D. (California at Berkeley); Charles B. Johnson, Ed.D. (Duke); Robert N. Sawyer, Ed.D. (Wyoming)

Professor Emeritus

W. Scott Gehman, Jr., Ph.D. (Pennsylvania State)

Adjunct Associate Professor

Robert A. Pittillo, Jr., Ed.D. (Duke)

Lecturers

John A. Fowler, M.D. (Bowman Gray); Richard H. Leach, Ph.D. (Princeton)

Qualified juniors, seniors, and graduate students may enroll in appropriate education courses as electives. Further information may be obtained from the Director of Graduate Studies.

Courses of Instruction

205. Selected Topics
206. Selected Topics
211. Education and the Mass Media
212S. Pedagogy and Political Economy: a World View
215. Seminar in Teaching

215S. Secondary Education: Principles
216. Secondary Education: Internship
225. The Teaching of History and the Social Studies
232. Psychoeducational Counseling with Families

236. Teaching Developmental and Remedial
   Reading in the Secondary School
242. Group Counseling
246. Teaching of Mathematics
276. Teaching of High School Science
350, 351. Directed Activities in Education
357. Directed Research

Engineering

Professor Earl H. Dowell, Sc.D. (Massachusetts Inst. of Tech.), *Dean*

The School of Engineering offers programs of study and research leading to the M.S. and Ph.D. degrees with a major in biomedical, civil and environmental, or electrical engineering, or in mechanical engineering and materials science. These programs are designed to provide a fundamental understanding of the engineering sciences, which are based on mathematics and the physical sciences, and to develop experience in the art of engineering, which includes strong elements of intuition, imagination, and judgment. Engineering graduate students may participate in seminars appropriate to their fields of study.

A minimum of 30 units of earned graduate credit beyond the bachelor's degree is required for the M.S. degree: 12 in the major, 6 in related minor work (usually mathematics or natural science), 6 in either the major or minor subject or in other areas approved by the major department, and 6 for a research-based thesis. A nonthesis option requiring 30 units of course credit is available. Each of the departments imposes additional requirements in the exercise of this option. There is no language requirement for this degree.

A minimum of 60 units of earned graduate credit beyond the bachelor's degree is required for the Ph.D. degree. In civil and environmental engineering and electrical engineering, 24 units are required in the major field and 12 units in a related minor field (often mathematics or natural science), 12 in either the major or minor subject or other areas approved by the major department, and 12 for a research-based dissertation. In biomedical and mechanical engineering there are no specific course requirements; each program is planned to meet individual needs. Doctoral students are required to pass qualifying and preliminary examinations which may be either written, oral, or a combination of written and oral components, at the discretion of the committee and the department.

Biomedical Engineering

Professor James H. McElhaney, Ph.D. (West Virginia), *Chairman*
Professor Robert Plonsey, Ph.D. (California at Berkeley), *Director of Graduate Studies*

Professors
   Howard G. Clark, Ph.D. (Maryland); William E. Hammond, Ph.D. (Duke); Robert M. Hochmuth, Ph.D. (Brown); Loren W. Nolte, Ph.D. (Michigan); Theo C. Pilkington, Ph.D. (Duke); Olaf T. von Ramm, Ph.D. (Duke); Myron L. Wolbarsht, Ph.D. (Johns Hopkins)

Associate Professors
   Donald S. Burdick, Ph.D. (Princeton); Ronald J. Jaszczak, Ph.D. (University of Florida); Stephen J. Riederer, Ph.D. (Wisconsin)

Assistant Professors
   Frederick H. Daniels, Ph.D. (Columbia); Christine E. Miller, Ph.D. (Stanford); Sanjeev D. Nandedkar, Ph.D. (University of Virginia); Gregg E. Trahey, Ph.D. (Duke)

Research Professor
   Frederick L. Thurstone, Ph.D. (North Carolina State)

Biomedical engineering is the discipline in which the physical, mathematical, and engineering sciences and associated technology are applied to biology and medicine. Contributions range from modeling and simulation of physiological systems through experimental research to solutions of practical clinical problems. The goal of the graduate program in biomedical engineering is to combine training in advanced engineering, biomedical engineering, and the life sciences so that graduates of the program can contribute at the most advanced professional level. The doctoral dissertation should demonstrate significant and original contributions to an interdisciplinary topic, accomplished as an independent investigator. The major, current, research areas are: biomechanics, biomedical materials, biomedical modeling, data acquisition and processing, medical imaging, and electrophysiology. Every biomedical engineering graduate student is required to serve as a teaching assistant as part of the graduate training.

Courses of Instruction

201. Electrophysiology
202. Biomedical Transfer Processes
205, 206. Microprocessors and Digital Instruments
211. Theoretical Electrophysiology
212. Theoretical Electrocardiography
215. Biomedical Materials and Artificial Organs
222. Principles of Ultrasound Imaging
230. Biomechanics
233. Modern Diagnostic Imaging Systems
235. Acoustics and Hearing
265. Advanced Topics in Biomedical Engineering

333. Biomedical Imaging
399. Special Readings in Biomedical Engineering

Courses Currently Unscheduled

204. Measurement and Control of Cardiac Electrical Events
207. Experimental Mechanics
221. Electrophysiological Techniques
243. Computers in Biomedical Engineering
311. Inverse Models

Civil and Environmental Engineering

Professor P. Aarne Vesiland, Ph.D. (North Carolina at Chapel Hill), *Chairman*
Professor Robert J. Melosh, Ph.D. (Washington), *Director of Graduate Studies*

Professors

Robert J. Melosh, Ph.D. (Washington); Bruce J. Muga, Ph.D. (Illinois); Senol Utku, Sc.D. (Massachusetts Inst. of Tech.); James F. Wilson, Ph.D. (Ohio State)

Associate Professors

Mrinmay Biswas, Ph.D. (Virginia); James D. Bryers, Ph.D. (Rice); Tomasz A. Hueckel, Ph.D. (Polish Academy of Science), D.Sc. (National Polytechnic Inst.); Miguel A. Medina, Jr., Ph.D. (Florida); Eric I. Pas, Ph.D. (Northwestern); J. Jeffrey Peirce, Ph.D. (Wisconsin); Henry J. Petroski, Ph.D. (Illinois); Kenneth H. Reckhow, Ph.D. (Harvard)

Assistant Professor

Carlos M. Marin, Ph.D. (Harvard)

A student may specialize in one of the following fields of study for either the M.S. or the Ph.D. degree: environmental engineering; geotechnical engineering and soil mechanics; mechanics of solids; materials engineering; fluid mechanics, water resources, and ocean engineering; structural engineering; and urban systems and transportation. Interdisciplinary programs combining study in some of the major areas with biological sciences, business administration, materials science, social sciences, political science, public policy studies, and other areas of engineering are also available.

With the approval of the department, a master's degree candidate in civil engineering may choose, in lieu of submitting a thesis, to complete an additional 6 units of course work plus a special project. If this alternative is elected, candidates are expected to take comprehensive examinations over their graduate course work, and also to defend orally their special projects.

Under the Reciprocal Agreement with Neighboring Universities, a student may include as a portion of the minimum requirements work offered by the Department of Environmental Sciences and Engineering of the University of North Carolina. Although related work normally is taken in the natural sciences or mathematics, a student whose major interest relates to the social or managerial sciences may take relevant work in these areas.

Courses of Instruction

201. Advanced Mechanics of Solids
204. Plates and Shells
205. Elasticity
210. Intermediate Dynamics
212. Mechanical Behavior and Fracture of Materials
215. Urban and Regional Systems Analysis
216. Transportation Planning and Policy Analysis
217. Transportation Systems Analysis
218. Engineering Management and Project Evaluation
225. Dynamic Engineering Hydrology
227. Groundwater Hydrology and Contaminant Transport
232. Reinforced Concrete Design
233. Prestressed Concrete Design
234. Advanced Structural Design in Metals
235. Foundation Engineering
236. Earth Structures
241. Environmental Engineering Chemistry and Biology
243. Unit Operations in Water Treatment
245. Pollutant Transport Systems
246. Water Supply Design
248. Solid Waste and Resource Recovery Engineering
249. Control of Hazardous and Toxic Waste
251. Systematic Engineering Analysis

254. Applications of Finite Element Analysis
257. Optimization of Structural Designs
258. Analysis of Dynamic and Nonlinear Behavior of Structures
265. Advanced Topics in Civil and Environmental Engineering
280. Engineering Aspects of Physical Oceanography
281. Experimental Systems
282. Port, Harbor, and Coastal Engineering
283. Ocean System Dynamics
301, 302. Fall and Spring Seminars
399. Special Readings in Civil and Environmental Engineering

Courses Currently Unscheduled

202. Advanced Mechanics of Solids II
221. Incompressible Fluid Flow
222. Open Channel Flow
223. Flow Through Porous Media
226. Operational Hydrology
231. Structural Engineering Analysis
238. Rock Mechanics
239. Physical Properties of Soils
247. Air Pollution Control
306. Plasticity
336. Advanced Soil Mechanics
337. Elements of Soil Dynamics
350. Advanced Engineering Analysis

Electrical Engineering

Professor H. Craig Casey, Jr., Ph.D. (Stanford), *Chairman*
Professor Peter N. Marinos, Ph.D. (North Carolina State), *Director of Graduate Studies*

Professors

Richard B. Fair, Ph.D. (Duke); William T. Joines, Ph.D. (Duke); Robert B. Kerr, Ph.D. (Johns Hopkins); Loren W. Nolte, Ph.D. (Michigan); Harry A. Owen, Jr., Ph.D. (North Carolina State); Theo C. Pilkington, Ph.D. (Duke); Kishor S. Trivedi, Ph.D. (Illinois); Paul P. Wang, Ph.D. (Ohio State); Thomas G. Wilson, Sc.D. (Harvard)

Associate Professors

Herbert Hacker, Ph.D. (Michigan); Hisham Z. Massoud, Ph.D. (Stanford)

Assistant Professors

John A. Board, Jr., Ph.D. (Oxford); Christopher R. Carroll, Ph.D. (Calif. Inst. of Tech.); Apostolos Dollas, Ph.D. (Illinois); Rhett T. George, Jr., Ph.D. (Florida)

Research Assistant Professors

Joanne B. Dugan, Ph.D. (Duke); Karen Z. Frenzel, Ph.D. (Duke); Ronald C. Wong, Ph.D. (Duke)

A student may specialize in any one of the following fields in working toward either the M.S. or the Ph.D. degree with a major in electrical engineering: computer-aided design, computer engineering, detection and estimation theory, digital signal processing, electromagnetic fields and microwaves, integrated circuit design and fabrication, microprocessor systems, robotics and control systems, solid-state devices and materials, solid-state power conditioning, and VLSI circuit design.

Recommended prerequisites for the graduate courses in electrical engineering include a knowledge of basic mathematics and physics, electric networks, and system theory. Students in doubt about their background for enrollment in specific courses should discuss the matter with the Director of Graduate Studies. The M.S. degree program includes either a thesis or a project and an oral examination. A qualifying examination is required for the Ph.D. degree program. This examination is intended to test both the breadth and depth of the student's understanding of basic electrical engineering concepts. There is no foreign language requirement.

Courses of Instruction

202. Digital Communication Systems
203. Random Signals and Noise
204. Computer Network Architecture
205. Signal Detection and Extraction Theory
206. Digital Signal Processing
207. Fault-Tolerant and Testable Computer Systems
208. Digital Computer Design
209. Microprocessor Fundamentals and Applications
210. Introduction to VLSI Systems
211. Quantum Mechanics
213. Modern Optics
214. Introduction to Solid-State Physics
215. Semiconductor Physics
216. Devices for Integrated Circuits
218. Integrated Circuit Engineering
219. Digital Integrated Circuits
224. Advanced Electronic Circuits
225. Microwave Electronic Circuits
234. Power Electronics: High-Power Circuits
235. Nonlinear Magnetic and Semiconductor Power Converters
236. Energy-Storage Power Converters
241. Linear Systems
250. Introduction to Robotics
251. Pattern Classification and Recognition
252. Computer Systems Organization

265. Advanced Topics in Electrical Engineering
271. Electromagnetic Theory
272. Electromagnetic Communication Systems
273. Optical Communication Systems
308. Advanced Topics in Digital Systems
310. CMOS VLSI Design
316. Advanced Physics of Semiconductor Devices
320. Integrated Circuit Fabrication Laboratory
333. Electronic Properties of Submicron Solid-State Devices
399. Special Readings in Electrical Engineering

Courses Currently Unscheduled

217. Lasers
222. Nonlinear Analysis
226. Modeling/Computer-Aided Analysis of Electronic Systems
227. Network Synthesis
243. Advanced Linear Systems Theory
302. Applied Information Theory and Statistical Estimation
305. Advanced Topics in Signal Processing
317. Quantum Electronics
324. Nonlinear Oscillations in Physical Systems
342. Optimal Control Theory
371. Advanced Electromagnetic Theory
373. Selected Topics in Field Theory

Mechanical Engineering and Materials Science

Professor Robert M. Hochmuth, Ph.D. (Brown), *Chairman*
Professor Charles M. Harman, Ph.D. (Wisconsin), *Director of Graduate Studies*

Professors

Adrian Bejan, Ph.D. (Massachusetts Inst. of Tech.); Jack B. Chaddock, Sc.D. (Massachusetts Inst. of Tech.); Franklin H. Cocks, Sc.D. (Massachusetts Inst. of Tech.); Earl H. Dowell, Sc.D. (Massachusetts Inst. of Tech.); Devendra P. Garg, Ph.D. (New York Univ.); Ulrich M. Gösele, Ph.D. (Max Planck Institut für Metallforschung, Stuttgart); George W. Pearsall, Sc.D. (Massachusetts Inst. of Tech.); Edward J. Shaughnessy, Jr., Ph.D. (Virginia); Marion L. Shepard, Ph.D. (Iowa State); Teh Yu Tan, Ph.D. (California at Berkeley)

Associate Professors

Donald B. Bliss, Ph.D. (Massachusetts Institute of Technology); Phillip L. Jones, Ph.D. (California at Los Angeles); Alician V. Quinlan, Ph.D. (Massachusetts Inst. of Tech.); Donald Wright, Ph.D. (Purdue)

Assistant Professors

Gale H. Buzzard, Ph.D. (North Carolina State); Josiah Doss Knight, Ph.D. (University of Virginia); David Needham, Ph.D. (University of Nottingham)

Research Assistant Professor

Roger Tran-Son-Tay, D.Sc. (Washington University)

The department offers programs of study and research leading to the M.S. and Ph.D. degrees in both Mechanical Engineering and Materials Science. Current

research areas available include: The dynamics of nonlinear fluid and structural systems and their associated limit cycle and chaotic motions, vortex dynamics and methods of predicting stability, acoustics in porous media, turbulent flow processes, electrohydro-dynamics, elastic and viscous properties of blood cells, diffusion through membranes, structure and properties of biological membranes, thermal design by entropy minimization, diffusion and point defects in semi-conductors, non-destructive testing through position annihilation spectroscopy, the fine structure of permanent magnet material, secondary transitions, relaxation and aging of selected polymers, interpenetrating polymer networks, mechanical properties of kidney stones, convective heat transfer, unsteady aerodynamics, artificial intelligence and expert sytems, robotics and controls, thermal performance of buildings, ecodynamic system and bioprocess engineering.

Courses of Instruction

202. Engineering Thermodynamics
205. Biochemical Engineering
206. Optimization of Bioprocess Kinetics
210. Intermediate Dynamics
211. Theoretical and Applied Polymer Science
212. Electronic Materials
214. Corrosion and Corrosion Control
215. Biomedical Materials and Artificial Organs
217. Fracture of Engineering Materials
221. Compressible Fluid Flow
226. Intermediate Fluid Mechanics
227. Advanced Fluid Mechanics
230. Modern Control and Dynamic Systems
234. Advanced Computer-Aided Engineering
236. Engineering Acoustics and Noise Control
240. Patent Technology and Law for Engineers
245. Applications in Expert Systems
265. Advanced Topics in Mechanical Engineering
270. Robot Control and Automation
277. Optimization Methods for Mechanical Design
323. Convective Heat Transfer
324. Conduction and Radiation Heat Transfer
331. Nonlinear Control Systems
399. Special Readings in Mechanical Engineering

Courses Currently Unscheduled

213. Advanced Materials Science
216. Materials Science and Solar Technology
218. Thermodynamics and Thermokinetics of Materials
219. Applied Surface Science: Crystal Growth and Analytical Techniques
222. Heat Transfer
223. Principles and Design of Heat Transfer Equipment
224. An Introduction to Turbulence
232. Nonlinear Analysis
235. Advanced Mechanical Vibrations
254. Solar Energy Thermal Processes
300. Advanced Projects in Mechanical Engineering
302. Advanced Thermodynamics
311. Behavior of Crystalline Solids
322. Mechanics of Viscous Fluids
327. Homogeneous Turbulence
328. Turbulent Shear Flow
333. Seminar in Control Systems
335. Analytical Methods in Vibrations
372. Finite Element Techniques in Design

English

Professor Stanley Fish, Ph.D. (Yale), *Chairman*
Professor Marianna Torgovnick, Ph.D. (Columbia), *Assistant Chairman*
Professor Robert F. Gleckner, Ph.D. (Johns Hopkins), *Director of Graduate Studies*

Professors

Carl Anderson, Ph.D. (Pennsylvania); Louis J. Budd, Ph.D. (Wisconsin), *James B. Duke Professor of English;* Edwin H. Cady, Ph.D. (Wisconsin), *Andrew W. Mellon Professor in the Humanities;* Bernard I. Duffey, Ph.D. (Ohio State); Oliver W. Ferguson, Ph.D. (Illinois); Wallace Jackson, Ph.D. (Pennsylvania); Frank Lentricchia, Ph.D. (Duke); Holger O. V. Nygard, Ph.D. (California at Berkeley); Annabel Patterson, Ph.D. (London); Lee Patterson, Ph.D. (Yale); Reynolds Price, B.Litt. (Oxford); Dale B. J. Randall, Ph.D. (Pennsylvania); Clyde de Loache Ryals, Ph.D. (Pennsylvania); Barbara Herrnstein Smith (Brandeis); Grover C. Smith, Ph.D. (Columbia); Victor H. Strandberg, Ph.D. (Brown); Jane Tompkins, Ph.D. (Yale); George W. Williams, Ph.D. (Virginia); Kenny J. Williams, Ph.D. (Pennsylvania)

Associate Professors

James Applewhite, Ph.D. (Duke); Ronald R. Butters, Ph.D. (Iowa); John Clum, Ph.D. (Princeton); A. Leigh DeNeef, Ph.D. (Pennsylvania State); Gerald E. Gerber, Ph.D. (Northwestern); Buford Jones, Ph.D. (Harvard); Elgin W. Mellown, Ph.D. (London); Deborah Pope, Ph.D. (Wisconsin)

Assistant Professors

Jane Gaines, Ph.D. (Northwestern); George D. Gopen, Ph.D. (Harvard); Joseph A. Porter, Ph.D. (California at Berkeley); Regina M. Schwartz (Virginia)

The department offers graduate work leading to the A.M. and Ph.D. degrees. A statement of the requirements for the A.M. and Ph.D. degrees may be obtained from the Director of Graduate Studies. The department requires a reading knowledge of at least one foreign language for the Ph.D. degree; an additional language or languages may be required by the student's committee.

Courses of Instruction

207. Old English Language and Literature
208. History of the English Language
209. Present-Day English
212. Middle English Literature: 1100 to 1500
221. Renaissance Prose and Poetry: 1500 to 1660
225. Renaissance Drama: 1500 to 1642
235. Restoration and Eighteenth-Century Literature: 1660 to 1800
241. Romantic Literature: 1790 to 1830
245. Victorian Literature: 1830 to 1900
251. British Literature since 1900
263. American Literature to 1865
267. American Literature: 1865 to 1915
269. American Women Writers
275. American Literature since 1915
281. Studies in Genre
283. Feminist Theory and the Humanities
287. Major Critical Thought
288. Special Topics
312. Studies in Middle English Literature
315. Studies in Chaucer
321. Studies in Renaissance Literature
324. Studies in Shakespeare
329. Studies in Milton
337. Studies in Augustanism

338. Studies in a Major Augustan Author
341. Studies in Romanticism
347. Studies in Victorianism
348. Studies in a Major Nineteenth-Century Author
353. Studies in Modern British Literature
361. Studies in American Literature before 1915
368. Studies in a Major American Author before 1915
375. Studies in Modern American Literature
376. Studies in a Modern Author (British or American)
381. Special Topics Seminar
383. Studies in Textual Criticism
385. Studies in Literary Criticism
390. Seminar in the Teaching of Writing
391. Tutorial in Special Topics
392. Tutorial in Journal Editing

Courses Currently Unscheduled

310. Studies in Old English Literature
380. Studies in Ballad and Folksong

Tutorials

Specialized subjects of study will be offered, numbered in the 390s, to accommodate the interests of advanced graduate students. Tutorials will be offered to single students or to small groups. Instruction will be conducted in weekly sessions, or in more frequently scheduled sessions, if the instructor wishes. Emphasis will be on independent reading and investigation, and oral and written reports. A substantial amount of writing will be required.

Students are advised to consult the Director of Graduate Studies about the availability of tutorials.

Forestry and Environmental Studies

Professor George F. Dutrow, Ph.D. (Duke), *Dean*
Professor William J. Stambaugh, Ph.D. (Yale), *Director of Graduate Studies*

Professors

Benjamin A. Jayne, Ph.D. (Yale); Kenneth R. Knoerr, Ph.D. (Yale); James G. Yoho, Ph.D. (Michigan State)

Associate Professors

Norman L. Christensen, Jr., Ph.D. (California at Santa Barbara); William F. Hyde, Ph.D. (Michigan); Kenneth H. Reckow, Ph.D. (Harvard); Curtis J. Richardson, Ph.D. (Tennessee)

Major and minor work is offered in the areas of natural resource science/ecology, natural resource systems science, and natural resource economics/policy. Programs of study and research lead to the A.M., M.S., and Ph.D. degrees. College graduates who have a bachelor's degree in one of the natural or social sciences, forestry, engineering, business, or environmental science will be considered for admission to a degree program. Students will be restricted to the particular fields of specialization for which they are qualified academically. Graduate School programs usually concentrate on some area of natural resource science/ecology, systems science, or economics/policy, while study in resource management is more commonly followed in one of the professional master's degree programs of the School of Forestry and Environmental Studies. For more complete program descriptions and information on professional training in forestry or environmental studies, the *Bulletin of Duke University: School of Forestry and Environmental Studies* should be consulted.

The specific degrees available in forestry and related natural resources through the Graduate School are: the A.M. (with or without a thesis), M.S. (with a thesis), and the Ph.D. Students majoring in forestry or environmental studies may be required to demonstrate satisfactory knowledge of one or two foreign languages for the Ph.D. degree.

Courses of Instruction

200. Student Projects
201. Field Studies
204. Forest Inventory, Growth, and Yield
205. Silviculture
207. Forest Pest Management
208. Fire Behavior and Use
210L. Forest Pathology
211L. Applied Ecology and Ecosystem Management
213. Forest Ecosystems
214. Ecology of Southern Appalachian Forests
215. Environmental Physiology
216. Applied Population Ecology
218. Barrier Island Ecology
221L. Forest Soils
230. Weather and Climate
231. Environmental Climatology
232. Microclimatology
234. Watershed Hydrology
236. Water Quality Management
237. Watershed Modeling and Management
251. Natural Resource Data Analysis

261. Remote Sensing for Resource Management
262. Forest Utilization
263. Harvesting and Transportation Systems
264. Manufacturing Systems
267. Wildland and Wildlife Management
269. Business Aspects of Natural Resource Management
270. Resource Economics and Policy
283. Environmental Policy and Values
285. Land Use Principles and Policies
299. Independent Projects
301. Forest Nutrition Management
302. Models in Forest Productivity
305. Harvesting Effects on Productivity
306. Choices in Silviculture
308. Tree Biology
309. Forest Regeneration
311. Ecological Toxicology
312. Wetlands Ecology
314. Integrated Case Studies in Toxicology
318. Seminar in Ecotoxicology

322. Microbiology of Forest Soils
325. Ecologic Effects of Acid Deposition
330L. Environmental Monitoring and Instrumentation
331. Water Resource Systems
332. Air Quality Management and Modeling
335. Water Quality Modeling
350. Applied Regression Analysis
352. Matrix Methods for Resource Systems
355. Optimization Methods for Resource Management
357. Systems Ecology and Modeling
361. Forest Resource Management
363. International Trade and Forest Investment
366. Mathematical Modeling of Lake and Reservoir Water Quality
367. Seminar in Forest Resource Management
372, 373. Advanced Natural Resource Economics
381. Natural Resource Policy
384. Special Tax Problems for Industrial Timberland Owners
385. Decision Theory and Risk Analysis
388. Seminar in Resource and Environmental Policy
389. Seminar in Forest and Conservation History

Courses Currently Unscheduled

209. Forest Entomology
212. Ecosystem Dynamics in Forest Productivity
252. Computer Applications in Forestry
304. Forest Yield
310. Forest Productivity and Mineral Cycling
315. Effects of Pollutants on Ecosystems
317. Applied Ecological Problem Solving
319. Seminar in Natural Resource Ecology
320. Seminar in Integrated Case Studies in Natural Resource Analysis
338. Micrometeorology and Biometeorology Seminar

The University Program in Genetics

Professor Janis Antonovics, Ph.D. (Univ. Coll. of North Wales), *Director*

Professors

D. Bernard Amos, M.D. (Guys Hospital, London); Deepak Bastia, Ph.D. (Chicago); John E. Boynton, Ph.D. (California at Davis); Sheila Counce, Ph.D. (Univ. of Edinburgh); Nicholas Gillham, Ph.D. (Harvard); Samson R. Gross, Ph.D. (Columbia); Walter R. Guild, Ph.D. (Yale); Wolfgang Karl Joklik, D. Phil. (Univ. of Oxford), *James B. Duke Professor of Microbiology and Immunology*; Nicholas M. Kredich, M.D. (Michigan); Paul L. Modrich, Ph.D. (Stanford); Montrose J. Moses, Ph.D. (Columbia); R. Bruce Nicklas, Ph.D. (Columbia); Michael C. Ostrowski, Ph.D. (South Carolina at Columbia); Calvin L. Ward, Ph.D. (Texas); Frances Ellen Ward, Ph.D. (Brown); Robert E. Webster, Ph.D. (Duke)

Associate Professors

Sharyn Endow, Ph.D. (Yale); Ronald C. Greene, Ph.D. (California Inst. of Tech.); Arno L. Greenleaf, Ph.D. (Harvard); Michael S. Hershfield, M.D. (Pennsylvania); Tao-shih Hsieh, Ph.D. (California at Berkeley); Jack D. Keene, Ph.D. (Washington at Seattle); Elwood A. Linney, Ph.D.(California at San Diego); Mark D. Rausher, Ph.D. (Cornell); Deborah A. Steege, Ph.D. (Yale)

Assistant Professors

Mary Vickers Burdett, Ph.D. (Georgetown); Edward W. Holmes, M.D. (Pennsylvania); Stephen A. Johnston, Ph.D. (Wisconsin); Russel E. Kaufman, M.D. (Ohio State University); Kenneth N. Kreuzer, Ph.D. (University of Chicago); Frederick H. Schachat, Ph.D. (Stanford); Marcy K. Uyenoyama, Ph.D. (Stanford)

Adjunct Professors

John W. Drake, Ph.D. (California Inst. of Tech.); Burke H. Judd, Ph.D. (California Inst. of Tech.); Thomas Kunkel, Ph.D., (Cincinnati); John Charles Lucchesi, Ph.D. (California at Berkeley); Michael A. Resnick, Ph.D. (University of California at Berkeley); Akio Sugino, Ph.D. (Nagoya University, Japan)

The University Program in Genetics provides a coherent course of study in all facets of biology related to genetics. Graduate students registered in any of the biological sciences departments may apply to the faculty of the genetics program to pursue study and research leading to an advanced degree. It would be helpful if applicants for admission to the Graduate School indicated their interest in the genetics program at the time of application. Requests for information describing more completely the research interests of the staff, facilities, and special stipends and fellowships should be addressed to the Director, Genetics Program (Department of Botany).

Courses of Instruction

205. Molecular Biology and Genetics
215. Molecular Genetics I: Genetic Mechanisms
268. Molecular Biology II: Nucleic Acids
280. Principles of Genetics
281S. DNA, Chromosomes, and Evolution
283. Extrachromosomal Inheritance

285S. Ecological Genetics
286. Evolutionary Mechanisms
288. Mathematical Population Genetics
336. Contemporary Topics in Immunogenetics
350. Genetics Colloquium

Geology

Professor Ronald D. Perkins, Ph.D. (Indiana), *Chairman*
Professor S. Duncan Heron, Jr., Ph.D. (North Carolina at Chapel Hill), *Director of Graduate Studies*

Professor

Orrin H. Pilkey, Ph.D. (Florida State), *James B. Duke Professor of Geology*

Associate Professors

Bruce Hayward Corliss, Ph.D. (Univ. of Rhode Island); Thomas C. Johnson, Ph.D. (California at San Diego); Jeffrey A. Karson, Ph.D. (SUNY); Bruce R. Rosendahl, Ph.D. (California at San Diego)

Assistant Professors

Paul A. Baker, Ph.D. (California at San Diego); Sherman Bloomer, Ph.D. (California at San Diego); Richard A. Strelitz, Ph.D. (Princeton)

The Department of Geology offers graduate work leading to the M.S. and Ph.D. degrees. An undergraduate degree in geology is not a prerequisite for graduate studies, but a student must have had or must take a summer field geology course (or equivalent experience), mineralogy, igneous and metamorphic rocks, stratigraphy or sedimentation, and structural geology. In addition, the student must have had one year of college chemistry, one year of college physics, and mathematics through calculus.

Graduate courses in the Department of Geology provide specialized training in the fields of facies analysis, geological oceanography, sedimentary petrology, paleobiology, geophysics, and low-temperature geochemistry.

An acceptable thesis is required. There is no language requirement for the M.S. degree.

Courses of Instruction

200. Beach and Coastal Processes
203. Physical Oceanography
204. Chemical Oceanography
206S. Principles of Geological Oceanography
208S. Paleoceanography
209. Marine Sediments
212. Carbonate Facies Analysis: Recent and Ancient
214S. Sedimentary Petrography
215. Clastics Facies Analysis: Recent and Ancient
216. Field Analysis of South Florida Carbonates
217. Field Analysis of Ancient Sedimentary Sequences
230. Structural Geology and Tectonics
233. Oceanic Crust and Ophidites
236. Lithosphere Plate Boundaries

256. Advanced Geophysics
249. Marine Micropaleontology
251. Physics of the Earth
252. Exploration Seismology
255. Seismic Interpretation
260S. Hydrocarbon Exploration
270. Geochemistry
271. Isotope Geochemistry
272. Biogeochemistry
281S. Advanced Topics In Igneous Petrology
283S. Experimental Methods in Geology
292. Computer Methods in Geology
295S. Advanced Topics in Geology
371, 372. Advanced Topics in Geology

Courses Currently Unscheduled

253S. Geophysics

Germanic Languages and Literature

Associate Professor Frank Borchardt, Ph.D. (Johns Hopkins), *Chairman*
Associate Professor James L. Rolleston, Ph.D. (Yale), *Director of Graduate Studies*

Associate Professor

    A. Tilo Alt, Ph.D. (Texas)

Assistant Professor

    Michael M. Morton, Ph.D. (University of Virginia)

Professor Emeritus

    Leland R. Phelps, Ph.D. (Ohio State)

The Department of Germanic Languages and Literature offers graduate work leading to the A.M. degree. Students who expect to major in German should have had sufficient undergraduate courses in Germanic languages to enable them to proceed to more advanced work.

Students who wish to take courses in German as a related field should normally have completed a third-year course (in exceptional cases, a second year) of college German with acceptable grades.

Courses of Instruction

200S. Proseminar
201S, 202S. Goethe
205, 206. Middle High German
207S. German Romanticism
209S. Drama
210. The Eighteenth Century
211S. Nineteenth-Century Literature
214S. The Twentieth Century
215S. Seventeenth-Century Literature

216. History of the German Language
217S. Renaissance and Reformation Literature
218S. The Teaching of German
219. Applied Linguistics
230S. Lyric Poetry

Courses Currently Unscheduled

321, 322. Germanic Seminar

Health Administration

Professor J. Alexander McMahon, J.D. (Harvard), *Chairman*
Associate Professor Robert Taylor, Ph.D. (North Carolina at Chapel Hill), *Director of Graduate Studies*

Professors

    B. Jon Jaeger, Ph.D. (Duke); David G. Warren, J.D. (Duke)

Associate Professor

    David J. Falcone, Ph.D. (Duke)

Assistant Professors

    Anne L. Martin, Ph.D. (London); Donald S. Smith, M.H.A. (Minnesota)

Consultant

    Robert E. Toomey, LL.D. (Clemson)

Adjunct Associate Professors

    William L. Berry, Ph.D. (Harvard); Robert G. Winfree, M.A. (Iowa)

Adjunct Assistant Professors

    William J. Donelan, M.S. (Duke); John Kevin Moore, J.D. (University of Minnesota); Duncan Yaggy, Ph.D. (Brandeis)

The Department of Health Administration offers graduate work leading to the M.H.A. degree. The graduate program is offered through two academic years and leads principally toward a career in the corporate management of hospitals and other health care delivery organizations. Students without previous administrative experience in the health field are encouraged to apply for a twelve-month administrative fellowship following graduation. Admission to the program is based upon the capability for graduate study and demonstrated leadership potential of the candidate.

Courses of Instruction

301. Health System and the Environment
302. Organizational Behavior in Health Systems
303, 304. Health Systems and the Environment—Laboratory
311, 312. Leadership Seminar
321, 322. Strategic Planning for Health Services
325. Health Law for Management
327. Financial Management for Health Care Organizations
331. Human Resources Management

341, 342. Advanced Seminar in Health Care Institutional Management
343. Comparative Health Systems
352. Health Services for the Aged
354. Quality Assurance, Risk Management, and Liability Insurance
356. Health Policy Analysis
358. Cost Benefit Analysis
362. Planning and Managing Alternative Delivery Systems
371, 372. Directed Research

History

Professor Warren Lerner, Ph.D. (Columbia), *Chairman*
Professor Seymour Mauskopf, Ph.D. (Princeton), *Director of Graduate Studies*

Professors

Charles W. Bergquist, Ph.D. (Stanford); Clark R. Cahow, Ph.D. (Duke); John Cell, Ph.D. (Duke); William Chafe, Ph.D. (Columbia); Joel G. Colton, Ph.D. (Columbia); Calvin D. Davis, Ph.D. (Indiana); Robert F. Durden, Ph.D. (Princeton); Irving B. Holley, Jr., Ph.D. (Yale); Bruce R. Kuniholm, Ph.D. (Duke); John F. Oates, Ph.D. (Yale); John F. Richards, Ph.D. (California at Berkeley); Alex Roland, Ph.D. (Duke); Anne Firor Scott, Ph.D. (Radcliffe); William E. Scott, Ph.D. (Yale); John J. TePaske, Ph.D. (Duke); Ronald Witt, Ph.D. (Harvard); Charles R. Young, Ph.D. (Cornell)

Associate Professors

Arif Dirlik, Ph.D. (Rochester); Peter C. English, M.D., Ph.D. (Duke); David Barry Gaspar, Ph.D. (Johns Hopkins); Raymond Gavins, Ph.D. (Virginia); Lawrence C. Goodwyn, Ph.D. (Texas); Andrew Gordon, Ph.D. (Harvard); Martin Miller, Ph.D. (Chicago); Sydney Nathans, Ph.D. (Johns Hopkins); William M. Reddy, Ph.D. (Chicago); Peter H. Wood, Ph.D. (Harvard)

Assistant Professors

Richard Davis, Ph.D. (Princeton); Janet J. Ewald, Ph.D. (Wisconsin); Monica Green, Ph.D. (Princeton); Cynthia B. Herrup, Ph.D. (Northwestern); Alexander Keyysar, Ph.D. (Harvard); Kristen B. Neuschel, Ph.D. (Brown University); William M. Reddy, Ph.D. (Chicago)Thomas Robisheaux, Ph.D. (Virginia);

Professors Emeriti

Arthur Ferguson, Ph.D. (Cornell); John Hope Franklin, Ph.D. (Harvard), *James B. Duke Professor Emeritus of History*; Harold T. Parker, Ph.D. (Chicago); Richard A. Preston, Ph.D. (Yale); Theodore Ropp, Ph.D. (Harvard); Richard L. Watson, Ph.D. (Yale)

The Department of History offers graduate work leading to the A.M. and Ph.D. degrees. Candidates for the A.M. degree must have a reading knowledge of at least one ancient or modern foreign language related to their programs of study and have completed successfully a substantial research paper, or two seminar papers, normally the product of a year's seminar or two semester courses. The paper(s) must be approved by two readers, the supervising professor and a second professor from the graduate staff. Students anticipating a May degree must have their papers read and approved by April 15; those anticipating a September degree must have their papers read and approved by August 1.

Candidates for the degree of Doctor of Philosophy prepare themselves for examinations in four fields, at least three of which shall be in history. The choice of fields is determined in consultation with the student's supervisor and the Director of Graduate Studies. The department offers graduate instruction in the fields of Africa, Afro-American history, ancient history, medieval and early modern Europe, modern Europe, American history, Britain and the Commonwealth, Imperial Russia, Soviet Russia, Latin America, South Asia, China, modern Japan, military history, history of science, and history of medicine. The candidate for the Ph.D. degree must have a reading knowledge of two foreign

languages to be picked in conjunction with the candidate's supervisor. In certain cases, an alternative to the second language may be chosen if approved by both the candidate's supervisor and the Director of Graduate Studies. Such an alternative must take the form of successful completion of a course or courses which would appreciably increase the candidate's methodological proficiency; such as a graduate course in statistics, archaeology, demography, numismatics, cartography, or a summer training program for developing methodological skills. A course or courses in a discipline outside history;mdanthrpology, literature, sociology, political science, ecology, geography, etc.— will not necessarily qualify as an alternative a second language. Also, the alternative must be in addition to any previous undergraduate work in the methodology. Whether satisfied by two languages or by one language and an alternative, the requirement must be met prior to the preliminary examination.

Ancient History. For courses in ancient history which may be taken for credit in either history or classical studies, see Classical Studies.

Courses of Instruction

201S. The Russian Intelligentsia and the Origins of the Revolution
202S. The Russian Revolution
207, 208. Constitutional History of Britain: The Rise of the Common Law
215-216. The Diplomatic History of the United States
217S, 218S. Western Europe in the Twentieth Century
219S, 220S. History of Science and Technology
221. Problems in the Economic and Social History of Europe, 1200-1700
222. Problems in the Intellectual History of the European Renaissance and Reformation
227-228. Recent United States History: Major Political and Social Movements
229S, 230S. Revolution in Modern Europe, 1789-1919
231S, 232S. Problems in the History of Spain and the Spanish Empire
233. Slave Resistance and Social Control in New World Societies
234S. Political Economy of Development: Theories of Change in the Third World
237S. Europe in the Early Middle Ages
238S. Europe in the High Middle Ages
239S. History of Socialism and Communism
241-242. United States Constitutional History
243-244. Marxism and History
245, 246. Social and Intellectual History of China

247. History of Modern India and Pakistan, 1707-1857
248. History of Modern India and Pakistan, 1857 to the Present
249-250. Social and Intellectual History of the United States
253S, 254S. European Diplomatic History, 1871-1945
259. Archaic Greece
262. Problems in Soviet History
265S. Problems in Modern Latin American History
266. Late Antiquity
267S, 268S. From Medieval to Early Modern England
269S-270S. British History, Seventeenth Century to the Present
273S, 274S. Topics in the History of Science
277S. The Coming of the Civil War in the United States, 1820-1861
278S. The Civil War in the United States and Its Aftermath, 1861-1900
279, 280. Health, Healing, and History
282S. Canada
284S. Feminist Theory and the Social Sciences
285S, 286S. Oral History
301-302. Research Seminar in History
307-308. Seminar in United States History
312. Seminar in the Teaching of History in College
314. Historical and Social Science Methodology
351-352. Colloquia
371-372. Research Seminars
399. Independent Study

The Master of Arts Program in Humanities

Professor Charles R. Young (Cornell), *Director*

The Master of Arts Program in Humanities is an interdepartmental program and is tailored to the needs of individual students. The candidate defines a theme and selects appropriate course work with the aid and approval of a supervising committee. Thirty units of course work and proficiency in reading a foreign language are required for completion of the program. The degree may be earned with or without a thesis. The candidate who chooses not to submit a thesis will submit instead at least two substantial

papers arising from course work for review by committee members, and meets with them to discuss his or her program in a final master's colloquium.

The program is open to holders of undergraduate degrees in any discipline who can demonstrate sufficient background in humanities to permit study at the graduate level. Admission is by regular application to the Graduate School. Students may enroll full time or part time (minimum of 3 units per term). Students considering entering the program may enroll in an appropriate graduate course or courses through the Office of Continuing Education, at the same time making their interests known to the Director of the Humanities Program.

The Master of Arts Program in Liberal Studies

This interdisciplinary program allows individuals with a variety of professional and personal educational interests the flexibility to pursue their interests across traditional disciplinary boundaries. The program is managed by an interdepartmental committee which advises students and directs their course of study. Students study primarily on a part-time basis and choose from an array of interdisciplinary courses developed specifically for this program. In addition to those courses, students may select other graduate-level courses that fit their individual needs and interests.

The MALS program consists of nine courses and a final project. These courses are offered during three academic terms (fall, spring, and summer). For more information on specific courses and other program requirements, a separate bulletin on the Master of Arts in Liberal Studies may be requested from the program director (122 Allen Building, Duke University, Durham, NC 27706).

The Ph.D. Program in Literature

Professor Fredric Jameson, Ph.D. (Yale), *Chairman*
Professor Annabel Patterson, Ph.D. (London), *Director of Graduate Studies*

Professors
Jonathan Arac, Ph.D. (Harvard); Stanley Fish, Ph.D. (Yale); Frank Lentricchia, Ph.D. (Duke); Barbara Herrnstein Smith, Ph.D. (Brandeis); Phillip Stewart, Ph.D. (Yale); Jane Tompkins, Ph.D. (Yale)

Associate Professors
A. Leigh DeNeef, Ph.D. (Pennsylvania State); Gustavo Perez Firmat, Ph.D. (Michigan); James Rolleston, Ph.D. (Yale); Jean-Jacques Thomas, Doctorat de 3e Cycle (Univ. of Paris)

Resource Faculty (All have Ph.D.'s—used for advising and supervision of students)
Frank L. Borchardt, Peter Burian, C. John Herington, Francis Newton, Linda Orr, Lee Patterson, Clyde de L. Ryals, Marcel Tetel, Bruce Wardropper

Visiting Scholars
Jean-Joseph Goux, Monique Wittig, Jane Gallop, Terry Eagleton, Toril Moi, Franco Moretti

The Graduate Program in Literature has as its goals the education of men and women who will be fully qualified to teach in departments of national literatures as well as in the humanities and other interdisciplinary programs. The program is not comparatist in the traditional sense but theoretical in focus, dedicated to the understanding of cultural history and the reshaping of literary studies in the context of contemporary thought. The program acknowledges the challenges posed by the emergence of non-Western literatures, by the increasing importance of oppositional cultures within the West (feminism, Marxism, discourse analysis), by the significance of new media such as film, and by the relationship between verbal and nonverbal arts such as painting and music. The newly-founded Duke Center for Critical Theory supplements and enhances the goals for the Graduate Program in Literature by annual conferences, special seminars, and

lectures presented by international scholars and thinkers. A full descriptive brochure is available from Professor A. Patterson, Duke University, 305 Carr Building, Durham, NC 27706.

Courses of Instruction

251. History of Criticism
252. Criticism and Literary Theory in the Twentieth Century
253. Philology, Linguistics, and the Roots of Literature
280. Semiotics for Literature
281. Paradigms of Modern Thought
282. Contemporary Literary Theory
283. Modernism

284. The Intellectual as Writer
285. Literature and Ideology
286. Topics in Legal Theory
287. Problems in Narrative Analysis
288. Basic Issues in the History of Literary Theory
289. Topics in Feminist Theory
290. Topics in Psychoanalytic Criticism
291. Topics in Popular Culture and the Media
300. Value and Evaluation

The University Program in Marine Sciences

Professor John D. Costlow, Ph.D. (Duke), *Director*
Professor Joseph S. Ramus, Ph.D. (California at Berkeley), *Assistant Director for Academic Programs* and *Director of Graduate Student Affairs*

Professors

Richard T. Barber, Ph.D. (Stanford); John Gutknecht, Ph.D. (North Carolina at Chapel Hill); David R. McClay,* Ph.D. (North Carolina at Chapel Hill); Orrin Pilkey, †Ph.D. (Florida State); Richard B. Searles,* Ph.D. (California at Berkeley)

Associate Professors

Celia Bonaventura, Ph.D. (Texas); Joseph Bonaventura, Ph.D. (Texas); Richard B. Forward, Ph.D. (California at Santa Barbara); Thomas C. Johnson, Ph.D. (California at San Diego); J. Bolling Sullivan, Ph.D. (Texas); John P. Sutherland, Ph.D. (California at Berkeley)

Professor Emeritus

Cazlyn Green Bookhout, Ph.D. (Duke)

Graduate students from any and all academic disciplines are encouraged to take professional training at the Marine Laboratory. The program operates year-round, providing course work in the marine sciences, an active seminar program, and facilities supporting dissertation research. Resident graduate students represent the Departments of Biochemistry, Botany, Forestry and Environmental Studies, Geology, Physiology, and Zoology. Ordinarily, dissertation advisers are resident as well, although this need not be the case. The Marine Laboratory has available several graduate student instructional assistantships and endowed fellowships during the academic year, including summer. In addition, tuition credits obtained from fellowship support may be applied to courses given both at the Marine Laboratory and the Durham campus.

Persons interested in graduate work in marine sciences should apply through one of the appropriate departments. Forms may be obtained from the Graduate School.

Applications for summer courses at the laboratory should be addressed to the Admissions Office, Duke University Marine Laboratory, Beaufort, North Carolina 28516. Additional information and the application form are included in the *Bulletin of Duke University: Marine Laboratory*. The application for enrollment in summer courses at the laboratory should be accompanied by transcripts of undergraduate and graduate work. Applications should be received as early as possible. Graduate students planning to enroll in courses or seminars offered during the fall or spring at the Marine Laboratory should

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*In residence during summer only.
†In residence during spring only.

notify the Admissions Office of the Marine Laboratory of such intent *prior* to the beginning of the respective semester.

Students registering for research should do so under the appropriate departmental numbers.

The following courses are offered at Beaufort. See the Marine Laboratory bulletin for the current schedule of courses.

Courses of Instruction

203. Physical Oceanography
203L. Marine Ecology
205S. Geological Oceanography
209S. Marine Sediments
209, 210. Independent Study
210. Individual Study
215L. Primary Productivity in the Seas
218. Barrier Island Ecology
219L. Benthic Marine Algae
245L. Macromolecules, Ecology, and Evolution
250L. Physiology of Marine Animals
274L. Marine Invertebrate Zoology
278L. Invertebrate Developmental Biology
295S. Advanced Topics in Geology:
Continental Margin Sedimentation

353, 354. Research
359, 360. Research
371, 372. Advanced Topics in Geology
_____ . Seminar

Courses Currently Unscheduled

204. Chemical Oceanography
219S. Membrane Physiology
220L, 220S. Adaptations of Organisms to the Marine
Environment
247L. Plant Ecology
263L. Tropical Seaweeds
266S. Marine Biochemistry and Genetics
276. Comparative and Evolutionary Biochemistry

Mathematics

Professor Michael Charles Reed, Ph.D. (Stanford), *Chairman*
Associate Professor Lawrence C. Moore, Jr., Ph.D. (California Inst. of Tech.), *Director of Graduate Studies*

Professors

William K. Allard, Ph.D. (Brown); J. Thomas Beale, Ph.D. (Stanford); Phillip A. Griffiths, Ph.D. (Princeton); David G. Schaeffer, Ph.D. (Massachusetts Inst. of Tech.); Joseph R. Schoenfield, Ph.D. (Michigan); Seth L. Warner, Ph.D. (Harvard); Morris Weisfeld, Ph.D. (Yale)

Associate Professors

Donald S. Burdick, Ph.D. (Princeton); Richard E. Hodel, Ph.D. (Duke); Joseph W. Kitchen, Jr., Ph.D. (Harvard); David P. Kraines, Ph.D. (California at Berkeley); Gregory F. Lawler, Ph.D. (Princeton); David R. Morrison, Ph.D. (Harvard); William L. Pardon, Ph.D. (Princeton); Richard A. Scoville, Ph.D. (Yale); David A. Smith, Ph.D. (Yale); Stephanos Venakides, Ph.D. (Courant Inst. of Mathematical Sciences)

Assistant Professors

Margaret Cheney, Ph.D. (Indiana); Carl Gardner, Ph.D. (Massachusetts Inst. of Tech.); Dana W. Nance, Ph.D. (Princeton); Leslie Saper, Ph.D. (Princeton); Chadmark L. Schoen, Ph.D. (Chicago); Mark A. Stern, Ph.D. (Princeton); John Sylvester, Ph.D. (Courant Inst. of Math. Sci.)

Adjunct Professors

Jagdish Chandra, Ph.D. (Rensselaer)

Visiting Assistant Professor

Leah Edelstein, Ph.D. (Weizmann Inst. of Science, Rehovot, Israel)

Graduate work in the Department of Mathematics is offered leading to the A.M. and Ph.D. degrees. Admission to these programs is based on the applicant's undergraduate academic record, level of preparation for graduate study, the Graduate Record Examination, and letters of recommendation.

All A.M. and Ph.D. candidates are required to pass a qualifying examination after completing their first year of graduate study. The A.M. degree with a major in mathematics is awarded upon completion of 30 units of graded course work and passing the qualifying examination. A thesis may be substituted for 6 units of course work only under special circumstances.

Candidacy for the Ph.D. is established by passing the qualifying examination at the Ph.D. level, completing the department's language requirements, and passing an oral preliminary examination. The preliminary examination is normally taken at the beginning of the third year. The preliminary examination is conducted by a committee selected by the rules of the Graduate School and the department. The examination can, at the student's option, consist of questions based either on the student's course work at Duke or on the specific area of research plus a minor subject selected by the student.

After admission to candidacy, the Ph.D. degree is awarded on the basis of the student's scholarly ability as demonstrated by the dissertation and its defense. The dissertation is the most important requirement in the award of the Ph.D. degree.

Courses of Instruction

200. Introduction to Algebraic Structures I
201. Introduction to Algebraic Structures II
203. Basic Analysis I
204. Basic Analysis II
205. Topology
206. Differential Geometry
221, 222. Numerical Analysis I, II
230. Mathematical Methods in Physics and Engineering I
231. Mathematical Methods in Physics and Engineering II
234. Mathematics for Quantum Mechanics
235. Topics in Mathematical Physics
238, 239. Topics in Applied Mathematics
240. Applied Stochastic Processes
241. Linear Models
242. Multivariate Statistics
250. Introductory Mathematical Logic
251. Set Theory I
252. Set Theory II
258, 259. Topics in Logic
260. Groups, Rings, and Fields
261. Commutative Algebra
268, 269. Topics in Algebra
271. Algebraic Topology
275. Differential Geometry

276. Topics in Differential Geometry
277. Topics in Algebraic Geometry
278, 279. Topics in Topology
280. Differential Analysis
281. Real Analysis I
282. Real Analysis II
283. Linear Operators
284. Topics in Functional Analysis
285. Complex Analysis
286. Topics in Complex Analysis
288, 289. Topics in Analysis
290. Probability
293, 294. Topics in Probability Theory
295. Fourier Analysis and Distribution
296. Ordinary Differential Equations
297. Partial Differential Equations I
298. Partial Differential Equations II
299. Topics in Partial Differential Equations
378, 379. Current Research in Topology
388, 389. Current Research in Analysis

Courses Currently Unscheduled

358-359. Current Research in Logic
368-369. Current Research in Algebra
387. Current Research in Mathematical Physics

Program in Medieval and Renaissance Studies

Professor Lee Patterson, Ph.D. (Yale), *Chairman* and *Director of Graduate Studies*

The graduate Program in Medieval and Renaissance Studies is an interdisciplinary program administered by the Duke University Center for Medieval and Renaissance Studies. In consultation with the Director of Graduate Studies, students in the program select courses in art, history, music, philosophy, religion, language, and literature (classical studies, English, German, and Romance languages). The program is described in the section on special programs; for a description of individual courses see the large *Bulletin of Duke University: Graduate School.*

Courses of Instruction

Department of Art and Art History
230S. Medieval and Byzantine Art and Architecture
232S. Romanesque and Gothic Art and Architecture
240. Italian Art
242S. Studies in Italian Renaissance Art
243S. Studies in Northern Art

Department of Classical Studies
221. Medieval Latin
312. Proseminar in Latin Paleography
Department of English
208. History of the English Language
210. Old English Literary Tradition
212. Middle English Literature: 1100 to 1500

221. Renaissance Prose and Poetry: 1500 to 1660
225. Renaissance Drama: 1500 to 1642
310. Studies in Old English Literature
312. Studies in Middle English Literature
315. Studies in Chaucer
321. Studies in Renaissance Literature
324. Studies in Shakespeare
329. Studies in Milton
383. Textual Criticism

Department of Germanic Languages and Literature
205, 206. Middle High German
215S. Seventeenth-Century Literature
216. History of the German Language
217S. Renaissance and Reformation Literature

Department of History
221. Problems in the Economic and Social History of Europe, 1200-1700
222. History of the Renaissance
237S. Europe in the Early Middle Ages
238S. Europe in the High Middle Ages
267S-268S. From Medieval to Early Modern England

Department of Music
201. Introduction to Musicology
211. Medieval Notation
212. Renaissance Notation
221. Music in the Middle Ages: Monophony
222. Music in the Middle Ages: Polyphony
223. Music in the Renaissance
312S. Seminar in Renaissance Music
351S. Studies in Musical Iconography

Department of Philosophy
218S. Medieval Philosophy
219S. Late Medieval and Renaissance Philosophy

Department of Religion
219. Augustine
236. Luther and the Reformation in Germany

241. Problems in Reformation Theology
334. Theology and Reform in the Later Middle Ages
337. Theology of St. Thomas Aquinas
338. Calvin and the Reformed Tradition
339. The Radical Reformation

Department of Romance Languages

French

211. History of the French Language
248. French Literature of the Seventeenth Century
325. French Prose of the Sixteenth Century
326. Topics in Renaissance Poetry
391, 392. French Seminar (medieval and Renaissance topics)

Italian

284, 285. Dante

Spanish

210. History of the Spanish Language
251. The Origins of Spanish Prose Fiction
253. Cervantes
254. Drama of the Golden Age
258. Spanish Lyric Poetry before 1700
391, 392. Hispanic Seminar (medieval and Renaissance topics)

Courses Currently Unscheduled

Classical Studies 327. Seminar in Byzantine History
English 380. Studies in Ballad and Folksong
Music 311S. Seminar in Medieval Music
Religion 206. Christian Mysticism in the Middle Ages
Religion 251. The Counter-Reformation and the Development of Catholic Dogma
Religion 344. Zwingli and the Origins of Reformed Theology

Microbiology and Immunology

Professor Wolfgang Karl Joklik, D.Phil. (Univ. of Oxford), *James B. Duke Professor of Microbiology and Immunology* and *Chairman*
Professor Hilda Pope Willett, Ph.D. (Duke), *Director of Graduate Studies*

Professors

D. Bernard Amos, M.D. (Guys Hospital, London), *James B. Duke Professor of Immunology*; Deepak Bastia, Ph.D. (Chicago); Dani P. Bolognesi, Ph.D. (Duke); Rebecca Buckley, M.D. (North Carolina at Chapel Hill); Peter Cresswell, Ph.D. (University of London); Eugene D. Day, Ph.D. (Delaware); Richard S. Metzgar, Ph.D. (Buffalo); Suydam Osterhout, M.D. (Duke), Ph.D. (Rockefeller University); Wendell F. Rosse, M.D. (Chicago); Hilliard F. Seigler, M.D. (North Carolina at Chapel Hill); Frances E. Ward, Ph.D. (Brown); Robert W. Wheat, Ph.D. (Washington)

Associate Professors

Dolph O. Adams, M.D., Ph.D. (North Carolina at Chapel Hill); Ronald B. Corley, Ph.D. (Duke); Jeffrey R. Dawson, Ph.D. (Case Western Reserve); Sharyn Endow, Ph.D. (Yale); Barton F. Haynes, M.D. (Baylor); Jack D. Keene, Ph.D. (Washington at Seattle); Elwood A. Linney, Ph.D. (California at San Diego); Thomas G. Mitchell, Ph.D. (Tulane); Harvey J. Sage, Ph.D. (Yale)

The department offers graduate work leading to the Ph.D. degree. Specialization is possible in molecular virology, viral oncology, cell biology, tumor biology, molecular microbiology, molecular genetics, immunochemistry, immunogenetics, cancer immunology, general immunology, and medical mycology.

Undergraduate preparation in the biological and physical sciences and in biochemistry is required. A brochure describing the Ph.D. degree program, prerequisites for admission, and research in the department can be obtained by writing the Director of Graduate Studies, Box 3020, Duke University Medical Center, Durham, North Carolina 27710.

Courses of Instruction

214. Fundamentals of Electron Microscopy
219. Molecular and Cellular Bases of Differentiation
221. Medical Microbiology
234. Introduction to Biostatistical Methods
244. Principles of Immunology
246S. Parasitic Diseases
252. General Virology and Viral Oncology
259. Molecular Biology I: Protein and Membrane Structure/Function
268. Molecular Biology II: Nucleic Acids
269. Advanced Cell Biology
291. Comprehensive Immunology
304. Molecular Membrane Biology

310. Molecular Development
323. Topics in Cell and Molecular Biology
324. Topics in Molecular Genetics
325. Medical Mycology
330. Medical Immunology
331.1-331.8. Microbiology Seminar
332.1-332.8. Immunology Seminar
336. Contemporary Topics in Immunogenetics

Courses Currently Unscheduled

219S. Seminar
236. Statistical Method in Human Genetics
242. Mechanisms of Microbial Pathogenicity
282. Molecular Microbiology

Music

The Department of Music offers graduate programs leading to the A.M. and Ph.D. degrees in musicology, the A.M. degree in composition, and the A.M. degree in performance practice. The department has traditionally emphasized the study of music within the framework of cultural and intellectual history. To this has been added more

recently emphases on theory and analysis, and on performance practice. In addition, there is a strong interest, both within the composition and musicology programs, in opera and musical theater. Students are encouraged to include work outside their main area of concentration in their degree programs.

Nondegree students and graduate students from other departments may be admitted to graduate courses by consent of the instructor, according to their level of achievement in the proposed area of study. Students may be admitted to the Program in Medieval and Renaissance Studies (see section on Medieval and Renaissance Studies). A reading knowledge of one foreign language is required for the A.M. in composition, musicology, and performance practice; two languages are required for the Ph.D. (one of which will normally need to be German). For many dissertation topics a third language may be required. During their first term in residence, students in all degree programs will take an advisory test in basic harmony, counterpoint and score reading, as a result of which certain remedial work may be suggested by the Director of Graduate Studies. A detailed description of the requirements for the A.M. and Ph.D. is available upon request from the Director of Graduate Studies.

Courses of Instruction

201. Introduction to Musicology
211, 212. Notation
213. Theories and Notation of Contemporary Music
215. Music Analysis
216. Analysis of Twentieth-Century Music
222. Music in the Middle Ages
223. Music in the Renaissance
224. Music in the Baroque Era
225. Music in the Classic Era
226. Music in the Nineteenth Century
227. Music in the Twentieth Century

231, 232, 233. Independent Study in Performance Practice and Interpretation
290. Independent Study
296S. Analysis of Contemporary Music
297, 298, 299. Composition
317S. Seminar in the History of Music
318S. Seminar in Performance Practice
341S. History of Music Theory to Rameau
351S. Studies in Musical Iconography
361S. Musical Organology
382S. Studies in Ethnomusicology

The University Program in Neurobiology

Professor Irving T. Diamond, Ph.D. (Chicago), *Director*

Professors

Carl Erickson, Ph.D. (Rutgers); Doyle G. Graham, M.D., Ph.D. (Duke); William C. Hall, Ph.D. (Duke); George G. Somjen, M.D. (Univ. of New Zealand)

Associate Professors

Bernard Kaufman, Ph.D. (Indiana); J. Victor Nadler, Ph.D. (Yale)

Recent advances in neurobiology have resulted in new methods, such as immunohistochemistry, and in closer ties among the various approaches to studying the nervous system. For example, research on the neuroanatomical basis of behavior is more dependent than ever before on the chemical and cellular study of neurons. To keep pace with these changes the program in neurobiology has been designed for a small number of students who wish to study the nervous system at several levels, ranging from the molecular to the behavioral. In planning course work, each student will be guided by an advisory committee whose members come from a variety of departments. All students will be advised to take courses in neuroanatomy, neurophysiology, neuropharmacology, and neuropsychology. The heart of the training is a research apprenticeship that leads to a Ph.D. dissertation. Each student must affiliate with one of the participating departments—anatomy, biochemistry, microbiology and immunology, pathology, pharmacology, physiology, psychology, and zoology—and must meet all the requirements of that department for the Ph.D. degree. Normally, the dissertation adviser and the student will be members of the same department. A complete list of faculty, including

research interests, will be made available to prospective students. *See course listings under the participating departments.*

Pathology

Professor Robert B. Jennings, M.D. (Northwestern), *James B. Duke Professor of Pathology* and *Chairman*
Professor Darell D. Bigner, M.D., Ph.D. (Duke), *Director of Graduate Studies*

Professors

Dolph O. Adams, M.D., Ph.D. (North Carolina at Chapel Hill); Edward H. Bossen, M.D. (Duke); William D. Bradford, M.D. (Western Reserve); Bernard F. Fetter, M.D. (Duke); Doyle G. Graham, M.D, Ph.D. (Duke); Donald B. Hackel, M.D. (Harvard); William W. Johnston, M.D. (Duke); Gordon K. Klintworth, M.D., Ph.D. (Univ. of Witwatersrand); John A. Koepke, M.D. (Wisconsin at Madison); Philip Pratt, M.D. (Johns Hopkins); Joachim R. Sommer, M.D. (Munich); F. Stephen Vogel, M.D. (Western Reserve); Benjamin Wittels, M.D. (Minnesota)

Associate Professors

Sandra H. Bigner, M.D. (Tennessee); Peter C. Burger, M.D. (Northwestern); Jane G. Elchlepp, M.D. (Iowa), Ph.D. (Chicago); Kenneth Scott McCarty, Jr., M.D., Ph.D. (Duke); George Michalopoulos, M.D., Ph.D. (Wisconsin); Salvatore V. Pizzo, M.D., Ph.D. (Duke); Keith Arnold Reimer, M.D., Ph.D. (Northwestern); Alfred P. Sanfilippo, M.D., Ph.D. (Duke); John D. Shelburne, M.D., Ph.D. (Duke); Peter Zwadyk, Jr., Ph.D. (Iowa)

Assistant Professors

John Lloyd Abernethy, Ph.D. (Duke); Randy L. Jirtle, Ph.D. (Wisconsin); Stanley C. Schold, Jr., M.D. (Arizona)

Adjunct Associate Professor

James A. Swenberg, D.V.M. (Minnesota), Ph.D. (Ohio State)

Adjunct Assistant Professor

Arnold R. Brody, Ph.D. (Colorado State)

Assistant Clinical Professor

Robin T. Vollmer, M.D. (Duke)

Assistant Medical Research Professor

Carol J. Wikstrand, Ph.D. (North Carolina at Chapel Hill)

The Department of Pathology offers graduate work leading to the M.S. and Ph.D. degrees with areas of specialization such as subcellular and molecular pathology. Course work is designed to give a broad background in classical and modern pathology with emphasis on the application of modern research techniques. Students will be required to take such courses as are necessary to obtain a broad foundation, as well as courses applicable to areas of speciality and research. Further information including brochures giving details of departmental facilities, staff, trainee stipends, and the M.D.-Ph.D. program are available from the Director of Graduate Studies.

Courses of Instruction

219. Molecular and Cellular Bases of Differentiation
250. General Pathology
251. Laboratory Course in General Pathology
258. Cellular and Subcellular Pathology
275. Fundamentals of Electron Microscopy and Biological Microanalysis
325. Cardiovascular Pathology
353. Advanced Neuropathology
355. Graduate Seminar in Pathology
357. Research in Pathology
361, 362. Autopsy Pathology
364. Systemic Pathology

367. Special Topics in Pathology
369. Ophthalmic Pathology
370. Developmental Pathology and Teratology
374. Pulmonary Pathology and Postmortem Pathophysiology
377. Pathology of the Kidney
380. Diagnostic Immunology
381. Cancer Biology
382. General Pathology for Toxicologists

Courses Currently Unscheduled
360. Cytochemistry

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Pharmacology

Professor Norman Kirshner, Ph.D. (Pennsylvania State), *Chairman*
Professor Elliott Mills, Ph.D. (Columbia), *Director of Graduate Studies*

Professors

Mohamed Bahie Abou-Donia, Ph.D. (California at Berkeley); Everett H. Ellinwood, Jr., M.D. (North Carolina at Chapel Hill); Leon Lack, Ph.D. (Columbia); Daniel B. Menzel, Ph.D. (California at Berkeley); Athos Ottolenghi, M.D. (Univ. of Pavia); Saul M. Schanberg, Ph.D., M.D. (Yale); Theodore A. Slotkin, Ph.D. (Rochester); Walter D. Watkins, Ph.D. (Michigan), M.D. (Colorado); Pelham Wilder, Jr., Ph.D. (Harvard)

Associate Professors

James N. Davis, M.D. (Cornell); Cynthia Moreton Kuhn, Ph.D. (Duke); J. Victor Nadler, Ph.D. (Yale); Charles B. Nemeroff, Ph.D., M.D. (North Carolina at Chapel Hill); James Edward Niedel, M.D., Ph.D. (Miami); Gerald M. Rosen, Ph.D. (Clarkson Coll. of Tech.); Harold C. Strauss, M.D. (McGill); A. Richard Whorton, Ph.D. (Vanderbilt)

Assistant Professors

Clinton Donald Kilts, Ph.D. (Michigan State); James O. McNamara, M.D. (Michigan); Rochelle D. Schwartz, Ph.D. (Georgetown); Stephen C. Strom, Ph.D. (Kansas); A. Richard Whorton, Ph.D. (Vanderbilt)

Professor Emeritus

Frederick Bernheim, Ph.D. (Univ. of Cambridge), *James B. Duke Professor Emeritus of Pharmacology*

Medical Research Professor

Gertrude B. Elion, D.M.Sc. (Brown)

Associate Medical Research Professor

Wilkie A. Wilson, Jr., Ph.D. (Duke)

Assistant Medical Research Professors

Jorge V. Bartolome, Ph.D. (Chile); Joanne M. Bell, Ph.D. (Washington); Daniel M. Lapadula, Ph.D. (New York University); Frederic J. Seidler, Ph.D. (Duke); Peter G. Smith, Ph.D. (Duke); Robert L. Wolpert, Ph.D. (Princeton)

The Department of Pharmacology offers a graduate program which leads to the Ph.D. degree. Training is available in the areas of behavioral, biochemical, cardiovascular, developmental and endocrine pharmacology, neuropharmacology, and toxicology. Because pharmacology is an interdisciplinary field, the department gives serious consideration to applicants with strong undergraduate backgrounds in biological, chemical, and neural or behavioral sciences. There is no foreign language requirement.

Courses of Instruction

200. Pharmacology: Mode Action of Drugs
210, 211. Individual Study and Research
219. Tutorial in Pharmacology
280. Student Seminar in Pharmacology
314. Integrated Case Studies in Toxicology
330. Pharmacological Basis of Clinical Medicine
331. Laboratory Methods in Pharmacology
333. Principles of Pharmacology and Toxicology I
334. Principles of Pharmacology and Toxicology II

347, 348. Seminar in Toxicology
354. Mammalian Toxicology
360. Neuropharmacology
364. Neurotoxicology
370. Neurobiology I
372. Research in Pharmacology
417. Cellular Endocrinology

Philosophy

Professor David H. Sanford, Ph.D. (Cornell), *Chairman*
Associate Professor Carl J. Posy, Ph.D. (Yale), *Director of Graduate Studies*

Professors

Martin P. Golding, Ph.D. (Columbia); Edward P. Mahoney, Ph.D. (Columbia); William Bernard Peach, Ph.D. (Harvard)

Associate Professor

    Robert N. Brandon, Ph.D. (Harvard), *Andrew W. Mellon Associate Professor of Philosophy*

Assistant Professors

    Michael T. Ferejohn, Ph.D. (California at Irvine); Kathryn N. Jackson, Ph.D. (Toronto); Marshall R. Roderick, Ph.D. (Texas at Austin)

Professor Emeritus

    Paul Welsh, Ph.D. (Cornell)

The Department of Philosophy offers graduate work leading to the A.M. and Ph.D. degrees. Tutorial work complements formal instruction. Students may, after taking a balanced program, specialize in any of the following fields: the history of philosophy, logic, philosophy of science, epistemology, metaphysics, philosophy of mind, philosophical analysis, ethics, aesthetics, political philosophy, philosophy of law, philosophy of medicine, and philosophy of religion.

Individual programs of study are developed for each student. Prior to being admitted to candidacy for the Ph.D. degree, the student must demonstrate a competence in one foreign language and must successfully complete a series of essays and examinations covering the following: logic and formal philosophy; value theory; metaphysics, epistemology, and philosophy of science; and the history of philosophy. In these exercises students are expected to combine factual knowledge with critical understanding.

Work in a minor or related field, not necessarily confined to any one department, is encouraged but not required. A minor normally includes 6 units for the A.M. or the Ph.D. degree and may include more as a student's program requires or permits.

A student who meets the general requirements of the Graduate School may earn the A.M. degree in philosophy by passing an oral master's examination. This examination, which can be the defense of either a master's thesis or an alternative academic exercise approved by the department and the student's committee, is normally given in the student's fourth term of full-time registration. The examination can be given earlier in two special circumstances:

1. A student with a strong undergraduate background in philosophy who satisfies the department of his or her qualifications by submitting several samples of written work before beginning the program may be admitted to the master's program with the understanding that the master's examination can be given in the second or third term of full-time registration.

2. A student who combines the A.M. program in philosophy with another advanced degree program, such as the programs for the J.D., the M.D., or the Ph.D. in another field, will register as a full-time graduate student of philosophy for only two terms, the minimum registration that meets the general requirements of the Graduate School for the A.M. degree. These two terms of full-time registration need not be consecutive, and their position in the student's overall program is determined in individual cases. A student in a combined program will normally do some work in philosophy while registered in the student's primary program and do some work in the primary field while registered in philosophy. The master's examination can be given in the second term of full-time registration as a philosophy graduate student or in a later term when the student is registered in the primary program.

A student in the philosophy Ph.D. program who meets the general requirements of the Graduate School for the A.M. degree may earn this degree by passing the preliminary for the Ph.D. degree.

A reading knowledge of at least one foreign language, ancient or modern, is required for the Ph.D. degree. Students may not take their preliminary examinations until they have demonstrated this ability. More than one language may be required where this is judged appropriate to the research demanded by the candidate's dissertation.

Courses of Instruction

203S. Contemporary Ethical Theories
204S. Philosophy of Law
205S. Topics in Philosophy of History
206S. Responsibility
208S. Political Values
211S. Plato
217S. Aristotle
218S. Medieval Philosophy
219S. Late Medieval and Renaissance Philosophy
225S. British Empiricism
227S. Continental Rationalism
228S. Recent and Contemporary Philosophy
230S. The Meaning of Religious Language
231S. Kant's *Critique of Pure Reason*
233S. Methodology of the Empirical Sciences
234S. Problems in the Philosophy of Biology
235S. Hegel and Marx

250S. Topics in Formal Philosophy
251S. Epistemology
252S. Metaphysics
253S. Philosophy of Mind
254S. Philosophy of Religion
291S, 292S. Special Fields of Philosophy
311. Philosophy and Medicine
331, 332. Seminar in Special Fields of Philosophy

Courses Currently Unscheduled

202S. Aesthetics: The Philosophy of Art
232S. Recent Continental Philosophy

Physical Therapy

Professor Robert C. Bartlett, M.A. (New York Univ.), *Chairman*
Associate Professor Eleanor F. Branch, Ph.D. (Duke), *Director of Graduate Studies*

Associate Professors
Terry R. Malone, Ed.D. (Duke); Elia E. Villanueva, A.M. (Duke)

Assistant Professors
Pamela W. Duncan, M.A.C.T. (North Carolina at Chapel Hill); Grace C. Horton, B.S. (Duke)

Assistant Clinical Professor
Mary Ellen Riordan, M.S. (Wisconsin)

Clinical Associates
Daniel V. Dore, M.P.A. (Maine); Linda M. Lawrence, B.S. (SUNY at Buffalo)

The Department of Physical Therapy offers an entry level professional program leading to the M.S. degree. To be eligible for admission to the program, applicants must have obtained a baccalaureate degree and have a background in the basic sciences and social sciences, including course work in biology, chemistry, physics, and psychology.

The program is designed to provide for integration of classroom knowledge and clinical learning experiences essential for the competent practice of physical therapy. In view of this integrated curriculum, failure in a major course within a semester would prevent the student from continuing in the program. Major courses are all courses offered by the Department of Physical Therapy as well as required courses offered by the Department of Anatomy. A grade of *F* (or *noncredit* in the case of Physical Therapy 342, 343, and 344) in any of these courses will occasion withdrawal from the program. Program requirements also include a comprehensive examination, at the completion of the curriculum, and a research project. Further information may be obtained from the Director of Graduate Studies, Department of Physical Therapy, Box 3965, Duke University Medical Center, Durham, North Carolina 27710.

Courses of Instruction

210. Independent Study
301. Introduction to Scientific Inquiry
302. Research
303. Research
313. Physical Agents
314. Electrotherapy and Electrodiagnosis
317. Kinesiology
318. Arthrology and Pathokinesiology

319. Introduction to Evaluation and Patient Care
320. Evaluation and Therapeutic Procedures I
321. Evaluation and Therapeutic Procedures II
322. Evaluation and Therapeutic Procedures III
332. Physical Therapy and Health Services:
   Administration and Issues
333. Pediatrics
334. Introductory Pathology

344. Directed Clinical Experience in Physical
Therapy III

Courses Currently Unscheduled
304. Seminar in Applied Neurophysiology
324. Prosthetics and Orthotics

335. Orthopedics
336. Medical Sciences
340. Special Topics in Physical Therapy
342. Directed Clinical Experience in Physical
Therapy I
343. Directed Clinical Experience in Physical
Therapy II

Physics

Professor Frank C. DeLucia, Ph.D. (Duke), *Chairman*
Professor Henry A. Fairbank, Ph.D., (Yale), *Director of Graduate Studies*

Professors

L. C. Biedenharn, Jr., Ph.D. (Massachusetts Inst. of Tech.); Edward G. Bilpuch, Ph.D. (North Carolina at Chapel Hill); Ron Y. Cusson, Ph.D. (California Inst. of Tech.); Lawrence E. Evans, Ph.D. (Johns Hopkins); Alfred T. Goshaw, Ph.D. (Wisconsin); Moo-Young Han, Ph.D. (Rochester); Eric Herbst, Ph.D. (Harvard); Johannes Horst Max Meyer, Ph.D. (Univ. of Geneva); N. Russell Roberson, Ph.D. (Johns Hopkins); Hugh G. Robinson, Ph.D. (Duke); William D. Walker, Ph.D., (Cornell); Richard L. Walter, Ph.D. (Notre Dame); Henry R. Weller, Ph.D. (Duke)

Associate Professors

Robert P. Behringer, Ph.D. (Duke); Lloyd R. Fortney, Ph.D. (Wisconsin); Richard G. Palmer, Ph.D. (Cambridge); John Thomas, Ph.D. (Massachusetts Inst. of Tech.)

Assistant Professors

Calvin R. Howell, Ph.D. (Duke); Seog Hwan Oh, Ph.D. (Massachusetts Inst. of Tech.)

Professor Emeritus

Harold W. Lewis, Ph.D. (Duke)

Adjunct Professors

Mikael Ciftan, Ph.D. (Duke); B. D. Guenther, Ph.D. (University of Missouri); Fearghus O'Foghludha, Ph.D. (National Univ. of Ireland); Herman R. Robl, Ph.D. (Univ. of Vienna)

The Department of Physics offers graduate work for students wishing to earn the A.M. or Ph.D. degree. In addition to a balanced program of basic graduate courses, the department offers specialized courses and seminars in several fields in which research is being done by faculty and staff.

With the help of faculty advisers, students select a course program to fit their needs, including work in a related field, usually mathematics or chemistry. Students are encouraged to begin research work early in their careers.

Courses of Instruction
211. Modern Physics
214. Introduction to Solid-State Physics
215. Introduction to Quantum Mechanics
217S, 218S. Advanced Physics Laboratory and Seminar
220. Electronics
240. Computer Applications to Physical Measurement
244. Nuclear and Particle Physics
302. Advanced Mechanics
303. Statistical Mechanics
304. Advanced Topics in Statistical Mechanics*
305. Introduction to Nuclear Physics
308. Introduction to High-Energy Physics
309. Solid-State Physics I
316. Principles of Quantum Theory
317. Intermediate Quantum Theory
318-319. Electromagnetic Field Theory
331. Quantum Electronics*

333. Electronic Properties of Submicron Solid State Devices
335. Molecular Spectroscopy
342. Theory of Elementary Particles*
346. Topics in Theoretical Physics*
351, 352. Seminar

Courses Currently Unscheduled
306. Low Temperature Physics
310. Solid-State Physics II
312. Phase Transitions and Critical Phenomena
330. Nuclear Structure Theory
341. Advanced Topics in Quantum Theory
343. Nuclear Physics
344. Advanced Nuclear Physics
345. High-Energy Physics
397, 398. Low Temperature and Solid-State Seminar

*Offered on demand.

Physiology

Professor Edward A. Johnson, M.D. (Univ. of Sheffield), *James B. Duke Professor of Physiology* and *Chairman*
Associate Professor Sidney A. Simon, Ph.D. (Northwestern), *Director of Graduate Studies*

Professors

J. J. Blum, Ph.D. (Chicago), *James B. Duke Professor of Physiology*; Irving T. Diamond, Ph.D. (Chicago); John W. Gutknecht, Ph.D. (North Carolina at Chapel Hill); Diane Hatchell, Ph.D. (Marquette); Frans F. Jöbsis, Ph.D. (Michigan); Melvyn Lieberman, Ph.D. (SUNY, Downstate Med. Center); Lazaro J. Mandel, Ph.D. (Pennsylvania); John W. Moore, Ph.D. (Virginia); George M. Padilla, Ph.D. (California at Los Angeles); Robert Plonsey, Ph.D. (California at Berkeley); Jacqueline A. Reynolds, Ph.D. (Washington); George G. Somjen, M.D. (Univ. of New Zealand); Madison S. Spach, M.D. (Duke); Charles Tanford, Ph.D. (Princeton), *James B. Duke Professor of Physiology*

Associate Professors

Nels C. Anderson, Ph.D. (Purdue); Peter B. Bennett, Ph.D. (Univ. of Southampton); Celia Bonaventura, Ph.D. (Texas); Joseph Bonaventura, Ph.D. (Texas); Marc Caron, Ph.D. (Univ. of Miami); Robert P. Erickson, Ph.D. (Brown); Joseph C. Greenfield, M.D. (Emory); J. Mailen Kootsey, Ph.D. (Brown); Johannes A. Kylstra, M.D., Ph.D. (Univ. of Leiden); Thomas J. McManus, M.D. (Boston); Elliott Mills, Ph.D. (Columbia); David W. Schomberg, Ph.D. (Purdue); Myron L. Wolbarsht, Ph.D. (Johns Hopkins)

Assistant Professors

Page A. W. Anderson, M.D. (Duke); Robert R. H. Anholt, Ph.D. (University of California—San Diego); Enrico Mario Camporesi, M.D. (Univ. of Milan); Vincent W. Dennis, M.D. (Georgetown); Stuart Handwerger, M.D. (Maryland); Ann E. LeFurgey, Ph.D. (North Carolina at Chapel Hill); Brian J. Nunn, Ph.D. (England); Andrew G. Wallace, M.D. (Duke); Andrew S. Wechsler, M.D. (SUNY, Downstate Med. Ctr.); William E. Yarger, M.D. (Baylor)

Professor Emeritus

Knut Schmidt-Nielsen, Ph.D. (University of Copenhagen)

Adjunct Assistant Professors

Reginald D. Carter, Ph.D. (Bowman Gray)

Associate Medical Research Professor

Avis L. Sylvia, Ph.D. (North Carolina at Chapel Hill)

Assistant Medical Research Professors

Gilbert Baumann, Dr.Sc. (Swiss Federal Inst. of Tech.); Michael Lee Hines, Ph.D. (Chicago); Bruce Klitzman, Ph.D. (Univ. of Virginia)

The Department of Physiology offers graduate work leading to the Ph.D. degree. Before undertaking this program a student should have a strong background in basic sciences including course work in mathematics, biology, physics, and chemistry through physical chemistry. Undergraduates with this background may have majors in any of the following areas: biology, chemistry, physics, mathematics, engineering, or computer sciences. There is no foreign language requirement.

Courses of Instruction

200. Medical Physiology
202. Basic Neurophysiology
204. Introduction to Modern Physiology
205. Design and Analysis of Biological Experiments
208. Respiratory System in Health and Disease
210. Individual Study
217. Membrane Transport
230. Molecular and Cellular Bases of Differentiation
272S. Physiology of the Central Nervous System
280. Student Seminar in Physiology
320. Gastrointestinal Physiology

321. Renal Physiology
370. Neurobiology I
372. Research in Physiology
390. Membrane Biology
401. Metabolic Physiology
417. Cellular Endocrinology
418. Reproductive Biology
424. Seminar in Reproductive Biology

Courses Currently Unscheduled

203. Introduction to Biophysics and Biophysical Chemistry
207. The Heart in Health and Disease

281. Teaching in Physiology
301. Oxygen and Physiological Function
302. Advanced Topics and Research Seminar in Smooth and Striated Muscle
362. Cardiac Muscle Physiology
383. Physiological Instrumentation

416. Biophysics of Excitable Membranes
419. Topics in Mathematical Physiology
420. Cellular Immunophysiology

Political Science

Professor Allan Kornberg, Ph.D. (Michigan), *Chairman*
Associate Professor Peter Lange, Ph.D. (Massachusetts Inst. of Tech.), *Director of Graduate Studies*

Professors

William Louis Ascher, Ph.D. (Yale); James D. Barber, Ph.D. (Yale), *James B. Duke Professor of Political Science;* Robert Bates, Ph.D. (Massachusetts Institute of Technology), *Luce Professor of Political Economy;* Ralph Braibanti, Ph.D. (Syracuse), *James B. Duke Professor of Political Science;* Peter G. Fish, Ph.D. (Johns Hopkins); Ole R. Holsti, Ph.D. (Stanford), *George V. Allen Professor of Political Science;* Donald L. Horowitz, LL.M., Ph.D. (Harvard); Jerry F. Hough, Ph.D. (Harvard), *James B. Duke Professor of Political Science;* Richard H. Leach, Ph.D. (Princeton); David L. Paletz, Ph.D. (California at Los Angeles); David E. Price, B.D., Ph.D. (Yale); Thomas A. Spragens, Jr., Ph.D. (Duke); Arturo Valenzuela, Ph.D. (Columbia)

Associate Professors

Albert Eldridge, Ph.D. (Kentucky); Sheridan Johns III, Ph.D. (Harvard); Margaret A. McKean, Ph.D. (California at Berkeley)

Assistant Professors

William James Booth, Ph.D. (Harvard); David T. Canon, Ph.D. (Minnesota); Robert M. Entman, Ph.D. (Yale); Michael A. Gillespie, Ph.D. (Chicago); Ruth Grant, Ph.D. (Chicago); Joseph M. Grieco, Ph.D. (Cornell); Herbert P. Kitschelt, Ph.D. (Bielefeld, West Germany); Timothy J. Lomperis, Ph.D. (Duke); Darryl Lamont Roberts, Ph.D. (Cornell); George Tsebelis, Ph.D. (Washington University); Jennifer Widner, Ph.D. (Yale)

Professors Emeriti

M. Margaret Ball, Ph.D. (Stanford); Fredrick N. Cleaveland, Ph.D. (Princeton); Robert Taylor Cole, Ph.D. (Harvard); Kazimierz Grzybowski, S.J.D. (Harvard); Hugh M. Hall, Jr., Ph.D. (Texas); John Hamilton Hallowell, Ph.D. (Princeton)

Adjunct Associate Professor
Jean F. O'Barr, Ph.D. (Northwestern)

The Department of Political Science offers graduate work leading to the A.M. and Ph.D. degrees. Before being admitted to candidacy for the Ph.D. degree, an applicant must have qualified for the A.M. degree.

Instruction is designed to prepare the student for teaching and research, for government service, and for other work related to public affairs. Before undertaking graduate study in political science, a student is ordinarily expected to have completed at least 12 semester hours of course work in political science. Instruction is currently offered in the following fields: American government and politics, comparative government and politics, political theory, and international relations.

The candidate for the degree of Doctor of Philosophy in political science must take at least sixteen courses in all, including twelve in the department, and demonstrate competence in at least two general fields of the discipline as well as in a third general field or in a specialized subfield or in a field external to the department. The candidate must also demonstrate a reading knowledge of two foreign languages or must demonstrate proficiency in one foreign language and in the use of statistics.

The terminal degree of Master of Arts, for those who do not intend to continue with doctoral studies, is awarded following successful completion of: (1) eight one-semester courses of 3 units each, at least half of which must be in political science; and (2) the A.M.

thesis. In addition, candidates for the A.M. degree must demonstrate competence in one foreign language or in statistics.

Further details on the graduate program in political science, the departmental facilities, the staff, and available financial aid may be obtained from the Director of Graduate Studies, Department of Political Science.

Courses of Instruction

201S. Problems in International Security
203S. Politics and the Media of Mass Communication
204S. Ethics in Political Life
207S. American Constitutional Interpretation
208S. Analyzing the News
209. Problems in State Government and Politics
211S. Current Problems and Issues in Japanese Politics
212S. Domestic Structures and Foreign Policies of Advanced Democratic States
213S. Theories of International Political Economy
214S. The Politics of Scarcity
215S. Philosophical Bases of Political Economy and Society
216S. Evolution of European Marxism
218S, 219S. Political Thought in the United States
220S. Problems in International Politics
222. Seminar: Modern Political Classics
223. Ancient Political Philosophy
224S. Modern Political Theory
225. Topics in Comparative Government and Politics: Western Europe
226S. Theories of International Relations
227. International Law
228S. Nineteenth- and Twentieth-Century Political Philosophy
229S. Contemporary Theory of Liberal Democracy
230. Introduction to Positive Political Theory
231. Crisis, Choice, and Change in Advanced Democratic States
232. Comparative Political Economy
233S. Quantitative Political Analysis II
234S. Political Economy of Development: Theories of Change in the Third World
235S. Comparative Development of Islam
236. Statistical Analysis
237S. Comparative Public Policy
240. American Political Behavior
245. Ethics and Policy Making
249. Comparative International Development and Technology Flow

251S. The American Presidency
252S. Seminar on Political Activists: Comparisons and Theories
253S. Comparative Government and the Study of Latin America
255. Political Sociology
256S. Arms Control and National Security Policy
259S. Low Intensity Conflict and the Lessons of Viet Nam
260. The Tradition of Political Inquiry
261. Politics and the Future
262S. International Communism
263S. Methods of Political Science
264. The President and the Federal Bureaucracy
267S. Policy Making in International Organizations
275. The American Party System
277. Comparative Party Politics
279. Political Protest and Collective Mobilization
282S. Canada
283S. Congressional Policy Making
286S. Judicial Administration
293. Federalism
303. Seminar on Statistics
305. Seminar in U.S. Foreign Policy
306. Political Development of the U.S. Fourth Circuit Courts
308. Individual Research
309. Seminar in International Relations
321. Seminar in Political Theory
324. Seminar in Comparative Politics (A)
325. Seminar in Comparative Politics (B)
326. Research Seminar in Comparative Government and Politics
332. Seminar on Political Economy: Micro Level
333. Seminar on Political Economy: Macro Level
340. Seminar in American Politics and Institutions
381. Research Seminar in Latin American Government and Politics

Courses Currently Unscheduled

280S. Comparative Government and Politics: Sub-Saharan Africa
360. Seminar in Government and Politics in the Soviet Union

Related Course Work in the School of Law

There may be graduate credit for course work completed in the Duke University School of Law, under regulations referred to in the larger Graduate School bulletin (see the section on academic regulations in the chapter on "Regulations" in that bulletin).

Psychology

Professor John E.R. Staddon, Ph.D. (Harvard), *Chairman*
Professor Carl J. Erickson, Ph.D. (Rutgers), *Director of Graduate Studies*

Professors

Irving E. Alexander, Ph.D. (Princeton); Robert C. Carson, Ph.D. (Northwestern); John D. Coie, Ph.D. (California at Berkeley); Philip R. Costanzo, Ph.D. (Florida); Irving T. Diamond, Ph.D. (Chicago), *James B. Duke Professor of Psychology*; Robert P. Erickson, Ph.D. (Brown); Warren G. Hall, Ph.D. (Johns Hopkins); Lynn Hasher, Ph.D. (Calfornia at Berkeley); Martin Lakin, Ph.D. (Chicago); Gregory R. Lockhead, Ph.D. (Johns Hopkins); David C. Rubin, Ph.D. (Harvard); Michael A. Wallach, Ph.D. (Harvard); Cliff W. Wing, Jr., Ph.D. (Tulane)

Associate Professors

Ruth S. Day, Ph.D. (Stanford); Carol O. Eckerman, Ph.D. (Columbia); Peter C. Holland, Ph.D. (Yale); Susan Roth, Ph.D. (Northwestern)

Assistant Professors

Theodore H. Dix, Ph.D. (Northwestern); Irwin Kremen, Ph.D. (Harvard); Martha Putallaz, Ph.D. (Illinois); Susan S. Schiffman, Ph.D. (Duke)

Professors Emeriti

Gregory A. Kimble, Ph.D. (Iowa); Harold Schiffman, Ph.D. (Princeton)

Adjunct Professors

H. Keith H. Brodie, M.D. (Columbia); Herbert F. Crovitz, Ph.D. (Duke); Linda K. George, Ph.D. (Duke); William C. Hall, Ph.D. (Duke); George L. Maddox, Ph.D. (Michigan State); Susan S. Schiffman, Ph.D. (Duke); Robert J. Thompson, Jr., Ph.D. (North Dakota); Jay M. Weiss, Ph.D. (Yale)

Adjunct Associate Professors

Paul J. Brounstein, Ph.D. (Maryland); John H. Casseday, Ph.D. (Indiana); Kenneth I. Spenner, Ph.D. (Wisconsin at Madison)

The department offers graduate work leading to the Ph.D. degree. The areas of concentration are biological, cognitive, and sensory sciences, personality, developmental, and clinical. A brochure is available from the Director of Graduate Studies which describes the program in more detail and gives information on financial assistance, facilities, and current research activities. The Psychology Department has no foreign language requirement.

Courses of Instruction

200. Advanced Neuroscience I
201. Advanced Neuroscience II
203S. Sensation and Perception
204S. Great Ideas in Psychology
210S. Cognition
212S. Human Memory
214S. Development of Social Interaction
215S. Cognitive Development
216S. Biological Psychology
217S. Social Psychology
219S. Physiological Foundations of Psychology
220S. Psycholinguistics
231S. Parent-Child Interaction
234S. Personality
238S. Electroencephalogram and Psychological Function
255S. Perinatal Behavior
261S. Modern Learning Theory
266. Comparative Neurobiology
267S. Brain Mechanisms of Behavior

270S. A-R. Selected Problems
272S. Physiology of the Central Nervous System
273S. Statistical Principles in Experimental Design
285S. Developmental Psychobiology
286S. Biological Basis of Hearing
289S. Psychology of Prevention
301. Group Psychotherapy and Group Influence Processes
302S. Personality Theory
305. Psychopathology
307. Introduction to Theories and Methods of Mainstream Psychotherapies
309. Seminar in Learning
310. Seminar in Perception
318. Measurement and Methods
319-320. Research Apprenticeship I
323, 324. Seminar in Community Psychology
329-330. Proseminar in Psychology

331-332. Research Apprenticeship II
335-336. Personality Assessment
343-344. Clinical Inquiry II
348. Psychotherapy with Children and Families
349-350. Practicum in Psychological Research
351. Developmental Psychopathology
352. Child Assessment
353. Research Practicum in Prevention

398. Graded Research
399. Special Readings in Psychology

Courses Currently Unscheduled

230S. Social Behavior of Animals
337. Seminar in Sensory Discrimination

Public Policy Studies

Professor Philip J. Cook, Ph.D. (California at Berkeley), *Director*
Associate Professor John B. McConahay, Ph.D. (California at Los Angeles), *Director of Graduate Studies*

Professors

William Louis Ascher, Ph.D. (Yale); James D. Barber, Ph.D. (Yale); Charles T. Clotfelter, Ph.D. (Harvard); David M. Eddy, M.D. (Virginia), Ph.D. (Stanford); Joel L. Fleishman, LL.M. (Yale); S. Malcolm Gillis, Ph.D. (Illinois); Donald L. Horowitz, LL.M., Ph.D. (Harvard); Jerry F. Hough, Ph.D. (Harvard); Bruce R. Kuniholm, Ph.D. (Duke); Helen Ladd, Ph.D. (Harvard); George W. Pearsall, Sc.D. (Massachusetts Inst. of Tech.); David E. Price, Ph.D. (Yale)

Associate Professors

Robert D. Behn, Ph.D. (Harvard); Joseph Lipscomb, Jr., Ph.D. (Vanderbilt); Wesley A. Magat, Ph.D. (Northwestern); Carol B. Stack, Ph.D. (Illinois)

Assistant Professors

Robert M. Entman, Ph.D. (Yale); Sudhir Shetty, Ph.D. (Cornell)

Professors of the Practice

Henry Geller, J.D. (Northwestern); Richard A. Stubbing, M.B.A. (Harvard), Ph.B. (Notre Dame); Duncan Yaggy, Ph.D. (Brandeis)

Lecturer

Bruce L. Payne, M.A. (Yale)

The graduate program in public policy studies is offered through the Institute of Policy Sciences and Public Affairs. The objective of the program is to prepare students for jobs, particularly in the public sector, which require analytical skills and a practical understanding of the processes by which policy is made and implemented.

The A.M. degree requires two academic years and a summer internship. The first year is devoted to core courses in policy analysis, including sequences in quantitative methods, economics, political analysis, and ethics. The summer internship is arranged with a federal, state, or local agency. The second-year curriculum includes course work in public management and macroeconomics, a concentration in a substantive policy area, and a masters "memo" to be researched and written on a problem of current policy concern.

Students who are concurrently enrolled in a Ph.D. program or a professional degree program (M.D., J.D., M.B.A., M.H.A., etc.) or who have already obtained such a degree, can apply for an abbreviated version of the A.M. program. Such students are excused from most second-year requirements, so ordinarily the A.M. in public policy can be completed in one additional year. Students usually apply for a joint degree program simultaneously with their applications to the graduate departments or professional schools, or during their first or second year of advanced study.

The institute does not award a Ph.D.

More information concerning the A.M. programs can be obtained by writing the Director of Graduate Studies.

Courses of Instruction

204S. Ethics in Political Life
215S. Public Policies to Save Lives
217. Microeconomics and Public Policy Making
218. Macroeconomic Policy
219. The Politics of the Policy Process
221. Analytical Methods I: Decision Analysis for Public Policy Makers
222. Analytical Methods II: Data Analysis for Public Policy Makers
223. Ethics and Policy Making
231. Analytical Methods III: Quantitative Policy Evaluation
232. Analytical Methods IV: Topics in Economic Policy
236S, 237S. Public Management I and II: Managing Public Agencies
238S. Public Budgeting and Financial Management
240S. Analyzing the News
241. Reporting the American People
245S. Leadership Tutorial
250S. Policy, Philanthropy, and the Arts
254. Transportation Planning and Policy Analysis
257. United States Policy in the Middle East

264S. Research Seminar: Topics in Public Policy I
267S. Policy Making in International Organizations
268. Federal Tax Policy
270S. Humanistic Perspectives on Public Policy
272. Resource Economics and Policy
278. Human Service Bureaucracies
283S. Congressional Policy Making
284S. Public Policy Process in Developing Countries
286S. Economic Policy Making in Developing Countries
290. Glasgow Seminar in Public Policy
303. Public Policy Workshop I
304.01. Public Policy Workshop II
305.01. Public Policy Workshop III
387. Research Tutorial in Public Policy
388. Research Tutorial in Public Policy
399. Special Readings in Public Policy Studies

Courses Currently Unscheduled

256. The Economics of Health Care
270S. Humanistic Perspectives on Public Policy

Religion

Associate Professor Kalman P. Bland, Ph.D. (Brandeis), *Chairman*
Professor Stanley Hauerwas, Ph.D. (Yale), *Director of Graduate Studies*

Professors

Dennis M. Campbell, Ph.D. (Duke); Elizabeth A. Clark, Ph.D. (Columbia); James L. Crenshaw, Ph.D. (Vanderbilt); Frederick Herzog, Th.D. (Princeton); Wesley A. Kort, Ph.D. (Chicago); Creighton Lacy, Ph.D. (Yale); Thomas A. Langford, Ph.D. (Duke); Bruce B. Lawrence, Ph.D. (Yale); C. Eric Lincoln, Ph.D. (Boston); Charles H. Long, Ph.D. (Chicago); George Marsden, Ph.D. (Yale); Eric M. Meyers, Ph.D. (Harvard); Robert T. Osborn, Ph.D. (Drew); D. Moody Smith, Ph.D. (Yale); Harmon L. Smith, Ph.D. (Duke); David C. Steinmetz, Th.D. (Harvard); Dan O. Via, Jr., Ph.D. (Duke); Geoffrey Wainwright, Dr. Théol. (Geneva); Orval S. Wintermute, Ph.D. (Johns Hopkins)

Associate Professors

Lloyd R. Bailey, Ph.D. (Hebrew Union Coll., Jerusalem); Roger J. Corless, Ph.D. (Wisconsin); Robert C. Gregg, Ph.D. (Pennsylvania); Carol L. Meyers, Ph.D. (Brandeis); Harry B. Partin, Ph.D. (Chicago); Melvin K. H. Peters, Ph.D. (Toronto)

Assistant Professor

Ted A. Campbell, Ph.D. (Southern Methodist); Sandra P. Robinson, Ph.D. (Chicago)

Professors Emeriti

William W. Beach, Ph.D. (Yale); David C. Bradley, Ph.D. (Yale); Stuart C. Henry, Ph.D. (Duke); Roland E. Murphy, S.T.D. (Catholic Univ. of America); William H. Poteat, Ph.D. (Duke); James Ligon Price, Jr., Ph.D. (Cambridge); Franklin W. Young, Ph.D. (Duke)

Adjunct Professor

Jack Murad Sasson, Ph.D. (Brandeis)

The Department of Religion offers graduate work leading to the A.M. and Ph.D. degrees. Students may major in one of seven fields: (1) Old Testament and Semitic studies, (2) New Testament and Christian origins, (3) history of Christianity, (4) Christian theology and ethics, (5) history of Judaism, (6) history of religions, and (7) religion and culture. They will be expected to take courses which will contribute to an adequate understand-

ing of their chosen fields of specialization and will be required to take two written preliminary examinations within their field of concentration.

In addition to course work in their major field, students will take such other courses in cognate fields as will contribute to the enrichment of their major studies and will be required to take one written preliminary examination in a single cognate area within the department. A minor requirement may be fulfilled by work in a cognate department, such as classical studies, history, philosophy, political science, or sociology, and will constitute the outside minor and material for a fourth written preliminary examination. There is, in addition, an oral examination conducted by the student's committee immediately subsequent to the written examinations.

The program of doctoral studies presumes a foundation in the academic study of religion. Students applying for graduate work in religion directly from an undergraduate program should have had a strong undergraduate major in religion, and will be accepted for the Ph.D. program only upon the satisfactory completion of the A.M. degree with the department.

The graduate program also offers an A.M. degree that is not linked to a specific Ph.D. field. Such study is intended to encourage individuals to pursue a variety of interests irrespective of whether they desire further graduate study. An A.M. concentration may be in any of the seven Ph.D. fields or in an individually designed program of study (such as Islamic studies or religion and the social sciences).

Courses of Instruction

200. Person and Work of Christ
204. Origen
206. Christian Mysticism in the Middle Ages
207, 208. Intermediate Biblical Hebrew
209. Old Testament Theology
213. Christian Ethics in America
215S. Theological Ethics
217. Islam in India
218. Religion in Japan
219. Augustine
220. Rabbinic Hebrew
221. Readings in Hebrew Biblical Commentaries
222. John Among the Gospels
223A-G. Exegesis of the Hebrew Old Testament
225. Living Issues in New Testament Theology
226A-F. Exegesis of the Greek New Testament I
227A-D. Exegesis of the Greek New Testament II
228. Twentieth-Century Continental Theology
230S. The Meaning of Religious Language
231S. Seminar in Religion and Contemporary Thought
232S. Religion and Literature
233. Modern Narratives and Religious Meanings
234. Early Christian Asceticism
235. Heresy: Theological and Social Dimensions of Early Christian Dissent
236. Luther and the Reformation in Germany
237. History of the Ancient Near East
238. Jewish Responses to Christianity
239. Introduction to Middle Egyptian I
240. Introduction to Middle Egyptian II
243. Archaeology of Palestine in Biblical Times
244. The Archaeology of Palestine in Hellenistic-Roman Times
245. Ethics in World Religions
246. Problems in Historical Theology
248. The Theology of Karl Barth
249. The Lord's Prayer
256. John Wesley in Controversial and Ecumenical Theology

257. New Testament Ethics
258. Coptic
259. Icon Theology
262. Marxist Ideology and Christian Faith
263. Third World Theology
264. The Sociology of the Black Church
265. The Religions of the West Africa Diaspora
266. Ethics and Health Care
279. Understandings of the Resurrection in Contemporary Thought
280. The History of Religions
281. Phenomenology and Religion
282. Myth and Ritual
283. Islam and Modernism
284. The Religion and History of Islam
285. Introduction to the History of Religions
287. The Scriptures of Asia
288. Buddhist Thought and Practice
289. Theology and Contemporary Secular Understandings of Human Nature
290. Current Problems in Christian Social Ethics
291. Historical Forms of Protestant Ethics
292. Happiness, Virtue, and Friendship
294. Christianity and the State
300. Systematic Theology: The Doctrine of the Trinity
302. Studies in the Intertestamental Literature
304. Aramaic
304A. Targumic Aramaic
305. The Septuagint
306. Language and Literature of the Dead Sea Scrolls
307. Syriac
308. Greek Patristic Texts
309. Hermeneutics
310. Readings in Judaica
315-316. Seminar: History of Religions
318. Seminar in the Greek Fathers
322. Nineteenth-Century European Theology

323A. Comparative Semitic I
323B. Comparative Semitic II
324. Readings in the History of Religion
325. Philosophical Theology I
326. Philosophical Theology II
329. Readings in Theology and Language
330. Contemporary Christologies
331. Eschatology
332. System in Theology
334. Theology and Reform in the Later Middle Ages
337. Theology of St. Thomas Aquinas
338. Calvin and the Reformed Tradition
340-341. Seminar in the New Testament
342. American Religious Biography
343. Readings in Ancient Near Eastern Wisdom Literature
346. Practical Reason and Personal Identity: Explorations in Narrative
350-351. Old Testament Seminar
352. Seminar in Christian Theology
353. Seminar on Text Criticism
360. Special Problems in Religion and Culture
362. Readings in Old Testament and Semitic Studies
363. Readings in New Testament and Christian Origins
364. Readings in History of Christianity
365. Readings in Christian Theology and Ethics
366. Readings in History of Religions
367. Readings in Religion and Culture
373-374. Elementary Akkadian
380. Existentialist Thought
383. Moral Theology in the Twentieth Century
384. Religious Dissent in American Culture
385. Religion in American Literature
386. Christianity in Dialogue with Other Faiths

387. Ethical Method
389. Christian Ethics and Contemporary Culture
395. Christian Thought in Colonial America
396. Liberal Traditions in American Theology

Courses Currently Unscheduled

221. Readings in Hebrew Biblical Commentaries
241. Problems in Reformation Theology
242. Life after Death in Semitic Thought
247. Readings in Latin Theological Literature
251. Counter-Reformation and Development of Catholic Dogma
252. Nineteenth- and Twentieth-Century Roman Catholic Theology
301. Seminar in Contemporary Christian Ethics
311. Pharisaic Judaism in the First Century
312. Pauline Theology
313. The Apostolic Fathers
314. Judaism and Christianity in the New Testament
317. Seminar in the Greek Apologists
319. The Gospel According to St. Matthew in Recent Research
320. Theology, Power, and Justice
324. Readings in the History of Religion
327. Philosophical Method in Religious Studies
328. Twentieth-Century European Theology
335. The English Church in the Eighteenth Century
339. The Radical Reformation
344. Zwingli and the Origins of Reformed Theology
397. Contemporary American Theology
398. Colloquium on the Teaching of Religion
401. Colloquium in Biblical Studies

Romance Languages

Professor John M. Fein, Ph.D. (Harvard), *Chairman*
Jean-Jacques Thomas, Doctorat de 3e Cycle (Univ. of Paris), *Director of Graduate Studies*

Professors

Miguel Garci-Gómez, Ph.D. (Catholic Univ.), Fredric R. Jameson, Ph.D. (Yale); Rafael Osuna, Ph.D. (Brown); Phillip Stewart, Ph.D. (Yale); Marcel Tetel, Ph.D. (Wisconsin); Bruce W. Wardropper, Ph.D. (Pennsylvania), *William H. Wannamaker Professor of Romance Languages*

Associate Professors

Ernesto Caserta, Ph.D. (Harvard); Alexander Hull, Ph.D. (Washington); Alice Yaeger Kaplan, Ph.D. (Yale); Linda Orr, Ph.D. (Yale); Gustavo F. Pérez, Ph.D. (Michigan)

Assistant Professor

David F. Bell III, Ph.D. (Johns Hopkins); Kathleen A. Ross, Ph.D. (Yale)

Professor Emeritus

Wallace Fowlie, Ph.D. (Yale)

Visiting Professor

Ariel Dorfman, M.A. (University of California at Berkeley)

The Department of Romance Languages offers graduate work leading to the A.M. and Ph.D. degrees in French and Spanish. Requirements for the A.M. may be completed by submission of a thesis or by passing a comprehensive examination in the major field.

Related work for the A.M. and Ph.D. degrees is required in a second Romance language or in any one or two of a number of other subject areas. A reading knowledge of one foreign language which is outside the major language is required.

In order to undertake graduate study in Romance languages, the entering student should have credit for at least 18 semester hours (or equivalent) above the intermediate level in the major language.

French

Courses of Instruction

200S. Seminar in French Literature
210. The Structure of French
211. History of the French Language
223. Semiotics for Literature
248. French Literature of the Seventeenth Century
251, 252. Literature of the Eighteenth Century
255. French Preromantic and Romantic Poetry
256. Modern Literature and History
257. Problems of Identity in the Nineteenth-Century French Novel
258. The Narrative of Social Crisis
261. French Symbolism
263. Contemporary French Theater
264. Contemporary French Poetry
265. French Literature of the Early Twentieth Century
266. French Literature of the Mid-Twentieth Century
267. Contemporary French Novel
290S. Studies in a Contemporary Figure
325. French Prose of the Sixteenth Century
326. Topics in Renaissance Poetry
391, 392. French Seminar
Graduate Reading Course

Spanish

Courses of Instruction

200S. Seminar in Spanish Literature
210. History of the Spanish Language
241. Colonial Prose of Spanish America
242. Colonial Poetry and Theater of Spanish America
245. Modern Spanish-American Poetry
246. Modern Spanish-American Fiction
248. Studies in Spanish-American Literature
251. The Origins of Spanish Prose Fiction
253. Cervantes
254. Drama of the Golden Age
258S. Spanish Lyric Poetry before 1700
262. The Romantic Movement
275. Modern Spanish Poetry
276. Modern Spanish Drama
277. Modern Spanish Novel
391, 392. Hispanic Seminar

Romance Languages

Courses of Instruction

218. The Teaching of Romance Languages
310. Computers for the Humanities

Italian

Courses of Instruction

283. Italian Novel of the Novecento
284. Dante
285. Dante

Slavic Languages and Literatures

Professor Magnus J. Krynski, Ph.D. (Columbia), *Chairman*

Associate Professor Emeritus

Bronislas de Leval Jezierski, Ph.D. (Harvard)

The Department of Slavic Languages and Literatures offers graduate courses in Russian language and literature and limited training in the language and literature of Poland.

Students should have sufficient preparation in the Russian language to enable them to read Russian classical literature in the original. Any presently unscheduled course will be taught in any semester upon request.

Courses of Instruction

201, 202. Russian Novel of the Nineteenth Century
225. Tolstoy
232. Dostoevsky

Courses Currently Unscheduled

230. Chekhov

Sociology

Professor Kenneth C. Land, Ph.D. (University of Texas), *Chairman*
Professor Joel Smith, Ph.D. (Northwestern), *Director of Graduate Studies*

Professors

Kurt W. Back, Ph.D. (Massachusetts Inst. of Tech.), *James B. Duke Professor of Sociology*; Linda K. George, Ph.D. (Duke); Alan C. Kerckhoff, Ph.D. (Wisconsin); George L. Maddox, Jr., Ph.D. (Michigan State); George C. Myers, Ph.D. (Washington); Erdman B. Palmore, Ph.D. (Columbia); Ida H. Simpson, Ph.D. (North Carolina at Chapel Hill); Edward A. Tiryakian, Ph.D. (Harvard)

Associate Professors

Gary Gereffi, Ph.D. (Yale); Angela O'Rand, Ph.D. (Temple); Kenneth I. Spenner, Ph.D. (Wisconsin); John Wilson, D.Phil. (Univ. of Oxford)

Professors Emeriti

John C. McKinney, Ph.D. (Michigan State); Jack J. Preiss, Ph.D. (Michigan State)

Research Professor

Kenneth G. Manton, Ph.D. (Duke)

The department offers graduate work leading to the A.M. and Ph.D. degrees in sociology. Students beginning work toward an advanced degree should have completed a minimum of 12 semester hours of acceptable courses in sociology and an additional 12 semester hours in related work (e.g., other social sciences, statistics, computer science, philosophy, mathematics). Accepted applicants who have not had such preparation may be required to take work beyond the usual requirements. Applicants for admission are required to take the verbal and quantitative aptitude tests of the Graduate Record Examination.

The Ph.D. program requires the student to take three core courses (Sociology 206, 207, 208) and a major and a minor specialization. Specializations (with the associated proseminar indicated in parentheses) include Life Course and Aging Studies (Sociology 221); Comparative and Historical Sociology (Sociology 222); Criminology, Criminal Justice, and the Sociology of Law (Sociology 223); Demography, Ecology, and Social Epidemiology (Sociology 224); and Organizations, Markets, and Work (Sociology 225). Requirements for major specialties vary between five and seven courses. Minor specialties require three or more courses. Including the two courses outside the department required by the Graduate School, a student entering with only an undergraduate degree and adequate course preparation would need to take a minimum of from thirteen to fifteen courses to satisfy degree requirements. Up to fifteen credits, the equivalent of five courses, may be transferred for graduate work taken elsewhere, with requirements adjusted as appropriate.

There is a qualifying procedure after three semesters, or the equivalent, to determine whether the student can proceed to the preliminary examination. The latter consists of a four-hour written examination covering the student's chosen major and minor specializations and a two-hour oral examination covering these areas plus the core material. Further details concerning the general departmental program, the specialties and their requirements, departmental facilities, the faculty, ongoing research, and stipends available may be obtained from the Director of Graduate Studies.

Courses of Instruction

200S. Exile and Frontiers: Finding a Definition of Home for the Twentieth Century
206. Sociological Theory
207. Social Statistics I: Basic Concepts and Methods
208. Survey Research Methods
211A-E. Proseminars in Sociological Theory
212. Social Statistics II: Linear Models, Path Analysis, and Structural Equation Systems
213. Social Statistics III: Discrete Multivariate Models

214. Comparative and Historical Methods
215. Basic Demographic Methods and Materials
216. Advanced Methods of Demographic Analysis
217A-F. Proseminars in Social Statistics and Research Methods
221A-D. Proseminars in Aging and Life Course Analysis
222A-D. Proseminars in Comparative and Historical Sociology

223A-E. Proseminars in Criminology, Criminal Justice, and the Sociology of Law
224A-E. Proseminars in Demography, Human Ecology, and Social Epidemiology
225A-E. Proseminars in Organization, Markets, and Work
226A-H. Proseminars in Social Institutions and Processes
234S. Political Economy of Development: Theories of Change in the Third World
255. Political Sociology
282S. Canada
298S, 299S. Seminar in Selected Topics

The University Program in Toxicology

Professor of Pathology Doyle G. Graham, M.D., Ph.D. (Duke), *Director*
Professor Mohamed B. Abou-Donia, Ph.D. (California at Berkeley), *Deputy Director*
James B. Duke Professor of Biochemistry Irwin Fridovich, Ph.D. (Duke), *Deputy Director*
Associate Professor Curtis J. Richardson, Ph.D. (Tennessee), *Deputy Director*

The University Program in Toxicology seeks to produce individuals with sound training in the scientific basis for toxicological research who will advance the science of this discipline. After broad general courses in epidemiology and statistics, pathology, and mammalian toxicology, students will be trained in one of three tracks: (1) as generalist toxicologists, with broad training in the principles and concepts of toxicology and the design of protocols for toxicological assessments; (2) as specialist toxicologists in those areas of toxicology research in which faculty members are currently productive: pulmonary toxicology, neurotoxicology, immunotoxicology, genetic toxicology (carcinogenesis), and biochemical toxicology; or (3) as ecotoxicologists with broad training in principles and concepts of both toxicology and ecology as they relate to the release, transport, exposure, accumulation, and effects of toxicants in the ecosystems.

The toxicology program faculty is comprised of members from the Departments of Biochemistry, Chemistry, Microbiology and Immunology, Pathology, Pharmacology, Physiology, Zoology, the School of Forestry and Environmental Studies, the Duke University Marine Laboratory, and several departments in the School of Medicine.

Students seeking the Ph.D. in one of the participating Graduate School departments may make initial application to either the program or one of the departments. All who apply directly to the program will be considered for admission by the program and the department of the student's choice. Students who apply initially for graduate study in one of the departments may also be nominated by that department for admission to the program. It is expected that most students will have a strong undergraduate preparation in mathematics and the physical and biological sciences with demonstrated excellence of performance as judged by grades in course work and letters of recommendation from former instructors.

Each student in the program will take a series of courses in toxicology as well as courses specified by his or her department. A student will be expected to choose a dissertation adviser in his or her department by the end of the first two semesters in the program, and will normally be expected to begin dissertation research during the third semester in residence. Upon satisfactorily completing all degree requirements in the program and in the department, students will be jointly recommended for the Ph.D. degree.

Further information may be obtained from the Director of the toxicology program (Department of Pathology).

Women's Studies

Associate Professor Jean F. O'Barr, (Northwestern), *Director*
Associate Professor Carol Meyers, (Brandeis), *Associate Director*

The Women's Studies Program provides a focal point within the university for the study of gender. Students enrolled in any of the university's departments and professional schools may participate in the program through enrollment in the courses listed below, through specialized study in independent research with any of the fifty-four faculty members associated with the program, and through pursuing an M.A. or Ph.D. thesis topic in feminist theory. Students considering a concentration in women's studies are

encouraged to consult the Director for assistance in tailoring a program of study suited to their individual professional needs. A graduate certificate in Women's Studies is offered to those doing IDC 211 and at least two other courses on women at the graduate level.

SIGNS: Journal of Women in Culture and Society is edited at Duke. Internships and work-study positions form an important part of the graduate education of students interested in feminist scholarship.

Courses of Instruction

Interdisciplinary Course 211. History of Feminist Theory

Interdisciplinary Course 283. Feminist Theory and the Humanities

Interdisciplinary Course 284. Feminist Theory and the Social Sciences

Courses on Women Offered by Departments

Department of Anthropology

215. The Anthropology of Women
220S. The Cultural Construction of Gender
241. The Rise of Civilization in Mesopotamia and Iran
272. Marxism and Feminism
280. American Marriage: A Cultural Approach

Comparative Literature

282. Structuralism, Post-Structuralism and After
289. Topics in Feminist Theory

English

269. American Women Writers
287. Feminist Literary Theory
353. Novels of E. M. Forster and Virginia Woolf

French

290. Studies in a Contemporary Figure: Wittig

History

227, 228. Recent United States History: Major Political and Social Movements
351.40. Colloquium in Women's History

Literature

302. New Criticism in Literary Theory

Political Science

200A. Contemporary American Feminism

Public Policy Studies

264. Women and Justice

Religion

234. Early Christian Asceticism

Romance Languages

391. French Prose of the 16th Century: Marguerite de Navaree

Sociology

277. Patterns of Personal Development

Zoology

Professor Nicholas W. Gillham, Ph.D. (Harvard), *Chairman*
Associate Professor Mark D. Rausher, Ph.D. (Cornell), *Director of Graduate Studies*

Professors

Richard T. Barber, Ph.D. (Stanford); John D. Costlow, Jr., Ph.D. (Duke); Donald J. Fluke, Ph.D. (Yale); Peter H. Klopfer, Ph.D. (Yale); Daniel A. Livingstone, Ph.D. (Yale), *James B. Duke Professor of Zoology*; David R. McClay, Ph.D. (North Carolina at Chapel Hill); R. Bruce Nicklas, Ph.D. (Columbia); H. Frederik Nijhout, Ph.D. (Harvard); John E. R. Staddon, Ph.D. (Harvard), *James B. Duke Professor of Zoology*; Vance A. Tucker, Ph.D. (California at Los Angeles); Steven Vogel, Ph.D. (Harvard); Stephen A. Wainwright, Ph.D. (California at Berkeley), *James B. Duke Professor of Zoology*; Calvin L. Ward, Ph.D. (Texas); Henry M. Wilbur, Ph.D. (Michigan)

Associate Professors

Richard B. Forward, Jr., Ph.D. (California at Santa Barbara); John G. Lundberg, Ph.D. (Michigan); Joan V. Ruderman, Ph.D. (MIT); John P. Sutherland, Ph.D. (California at Berkeley); Marcy K. Uyenoyama, Ph.D. (Stanford)

Assistant Professors

William E. Conner, Ph.D. (Cornell); Virginia Louise Roth, Ph.D. (Yale)

Professors Emeriti

Joseph R. Bailey, Ph.D. (Michigan); Cazlyn G. Bookhout, Ph.D. (Duke); John R. Gregg, Ph.D. (Princeton); Knut Schmidt-Nielsen, Dr.Phil. (University of Copenhagen); Karl M. Wilbur, Ph.D. (University of Pennsylvania)

Adjunct Professor

Klaus Schmidt-Koenig, Ph.D. (Univ. of Freiburg)

Lecturer

Mary M. Nijhout, Ph.D. (Harvard)

The Department of Zoology manages a variety of programs tailored to individual needs of students seeking the Ph.D. degree. The A.M. degree may be taken by students en route to the Ph.D., or by those who leave the doctoral program. Ordinarily, only students seeking the doctorate are admitted to the department.

In general, students entering the department will be equipped to pursue advanced degrees if they have completed an undergraduate major in biology along with some formal training in college-level chemistry, mathematics, physics, and foreign languages.

Nevertheless, in recognition and support of the modern trend toward interdisciplinary research, the department is prepared to accept promising students with less orthodox academic backgrounds and is ready to encourage any student wishing to undertake a program of study leading, in effect, to an interdisciplinary degree sponsored by the department.

Thus, all students are urged to search widely in both the *Bulletin of Duke University: Undergraduate Instruction* and the *Bulletin of Duke University: Graduate School* for information about the intellectual resources of the University. Special attention should be given to announcements of the Departments of Anatomy, Anthropology, Biochemistry, Botany, Chemistry, Geology, History, Mathematics, Microbiology and Immunology, Pharmacology, Philosophy, Physiology, Psychology, Sociology, and Zoology; announcements of the Schools of Engineering and Forestry and Environmental Studies should also be consulted.

Courses of Instruction

201L. Animal Behavior
203L. Marine Ecology
204L. Community Ecology
206S. Controversies in Biology
215L. Primary Productivity in the Seas
216L. Limnology
222L. Entomology
226L. Ichthyology
233. Principles of Insect Behavior
237L. Systematic Biology
244. Principles of Immunology
247S. Photobiology
249. Biomechanics
250L. Physiology of Marine Animals
259L. Laboratory in Biomechanics
269. Advanced Cell Biology

274L. Marine Invertebrate Zoology
278L. Invertebrate Developmental Biology
280. Principles of Genetics
283. Extrachromosomal Inheritance
286. Evolutionary Mechanisms
287S. Macroevolution
288. Mathematical Population Genetics
293L. Population Biology
295S, 296S. Seminar
353, 354. Research
360, 361. Tutorials

Courses Currently Unscheduled

261. Biology of Parasitism
355, 356. Seminar

Related Programs

The University Program in Cell and Molecular Biology. See announcement in this bulletin.

The University Program in Genetics. Genetics courses offered by the Department of Zoology are part of the University Program in Genetics; see announcement in this bulletin.

The University Program in Marine Sciences. Consult Marine Sciences in this bulletin for offerings at the Duke University Marine Laboratory.

Program in Tropical Biology. Fellowships are available for travel and subsistence in field-oriented programs in Latin America. Refer to Organization for Tropical Studies in this bulletin in the section on special programs.
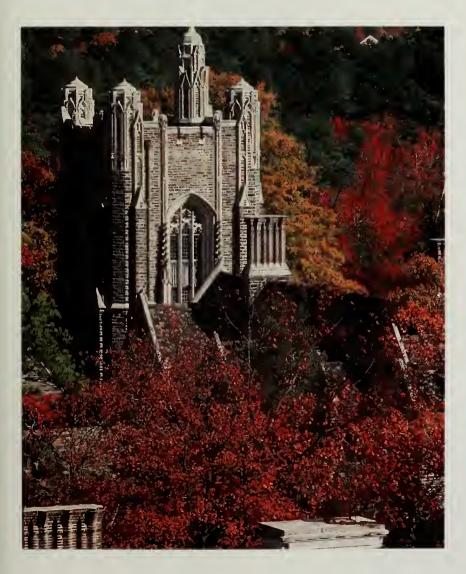
DUKE UNIVERSITY

CRS

Office of the University Architect
Department of Physical Planning
James A. Ward – Director

200   400

JANUARY 1978

WEST CAMPUS
MEDICAL CENTER
CENTRAL CAMPUS
EAST CAMPUS

HOSPITAL

WEST CAMPUS 77xx

1 DUKE CHAPEL (50)
2 DIVINITY SCHOOL (50)
3 LANGUAGE CENTER (50)
4 NORTH BUILDING (50)
5 OLD CHEMISTRY BUILDING (50)
6 SOCIAL SCIENCE (50)
7 DUKE HOSPITAL SOUTH (60)
8 DUKE HOSPITAL NORTH (60)
9 ALLEN BUILDING (50)
10 FLOWERS BUILDING (50)
11 DUKE UNIVERSITY UNION (50)
12 CROWELL QUAD (50)
13 SOCIAL SCIENCES (50)
14 PERKINS LIBRARY (50)
15 UNION BLDG (50)
16 PAGE AUDITORIUM (50)
17 BALDWIN AUDITORIUM (50)
18 CENTER FOR INTERNATIONAL STUDIES (48)
19 INSTITUTIONAL ADVANCEMENT OFFICE (78)
20 ALUMNI AFFAIRS (78)
21 WALLACE WADE STADIUM (46)
22 CAMERON INDOOR STADIUM (46)
23 PHYSICAL EDUCATION (46)
24 CARD GYMNASIUM (46)
25 FIELD HOUSE (46)
26 ATHLETIC & P.E. FACILITIES
27 FACULTIES
28 CREW HOUSE

MEDICAL CENTER 75xx

1 CLINICAL RESEARCH NO. 1 (60)
2 CLINICAL RESEARCH NO. 2 (60)
3 SCHOOL OF MEDICINE (60)
4 DUKE HOSPITAL SOUTH (60)
5 DUKE HOSPITAL NORTH (60)

CENTRAL CAMPUS 70xx and 71xx

EAST CAMPUS 72xx

NOT SHOWN ON MAP

bulletin of
Duke University
1987-88

Graduate School

bulletin of
Duke University
1987-88

Graduate School

ACADEMIC LIAISON
A. Leigh DeNeef
Associate Dean

The information in the bulletin applies to the academic year 1987-88 and is accurate and current, to the best of our knowledge, as of January, 1987. The University reserves the right to change programs of study, academic requirements, lecturers, teaching staffs, the announced University calendar, and other matters described in the bulletin without prior notice, in accordance with established procedures.

The *Bulletin of Duke University*, Volume 59, includes the following titles: *The Fuqua School of Business; The School of Forestry and Environmental Studies; Marine Laboratory; Undergraduate Instruction; The Graduate School; The Medical Center; The Divinity School; Information for Prospective Students; The Graduate School* (short form); *The School of Law;* and *Information and Regulations.*

Contents

Calendar of the Graduate School*

Summer 1987†

March
30 Monday—Beginning of registration for summer 1987.

May
5 Tuesday—Beginning this day, summer drop/adds must be approved by the Director of Graduate Studies
6 Wednesday—Last day for payment of Term I fees without late fee.
14 Thursday—Term I classes begin.
18 Monday—Drop/add for Term I ends at 4:00 P.M.

June
22 Monday—Last day for payment of Term II fees without late fee.
26 Friday—Term I final examinations begin.
27 Saturday—Term I final examinations end.
30 Tuesday—Term II classes begin.

July
2 Thursday—Drop/add for Term II ends at 4:00 P.M.

August
3 Monday—Final date for filing with the Graduate School office the intention to receive an advanced degree in September.
12 Wednesday—Term II final examinations begin.
13 Thursday—Term II final examinations end.

Fall 1987

August
24 Monday—Drop/add for graduate students who registered in March.
24 Monday—Consultations with Directors of Graduate Studies.
24 Monday—English examination for foreign students. (111 Biological Sciences Building—See chapter "Admission" for section on additional procedures for foreign students.)
25-26 Tuesday-Wednesday—Registration of all new and nonregistered returning students in the Graduate School.
31 Monday—Fall semester classes begin.

September
1 Tuesday—Late registration and drop/add.
4 Friday—Drop/add continues. Final date for changing registration with reduction in fees. Final date for changing enrollment status from full-time to part-time.
7 Monday—Labor Day. Classes in session.
8-11 Tuesday-Friday—Drop/add continues.
11 Friday—Final date for changes in registration which involve adding courses.
14-25 Monday-Friday—Drop/add continues for dropping course/seminar registration and adding equivalent units of ungraded research or residence.

October
16 Friday—Fall break begins.
21 Wednesday—Classes resume.

November
9-10 Monday-Tuesday—Registration for spring semester 1988.
25 Wednesday—Thanksgiving recess begins.
30 Monday—Classes resume.

December
1 Tuesday—Final date for filing with the Graduate School office the intention to receive an advanced degree in December.
4 Friday—Graduate Classes end.

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*The dates in this calendar are subject to change.
†The School of Forestry and Environmental Studies, the Fuqua School of Business, the Marine Laboratory, the Department of Health Administration, and the Department of Physical Therapy have different term lengths and/or starting dates during the summer; consult the appropriate bulletins and schedules.

5-13	Saturday-Sunday—Graduate reading period; length of 200-level course reading period is determined by the instructor.
13	Sunday—Founders' Day.
14-19	Monday-Saturday—Final examinations.

Spring 1988

January
5	Tuesday—Drop/add for graduate students who registered in November.
5	Tuesday—English examination for foreign students. (111 Biological Sciences Building—See chapter "Admission" for section on additional procedures for foreign students.)
6	Wednesday—Registration for all new and nonregistered returning students in the Graduate School.
7	Thursday—Spring semester classes begin.
8	Friday—Late registration and drop/add.
11-13	Monday-Wednesday—Drop/add continues.
13	Wednesday—Final date for changing registration with reduction in fees. Final date for changing enrollment status from full-time to part-time.
14-20	Thursday-Wednesday—Drop/add continues.
20	Wednesday—Final date for changes in registration which involve adding courses.
21-29	Thursday-Friday—Drop/add continues for dropping course/seminar registration and adding equivalent units of ungraded research or residence.

February
1	Monday—Final date for filing with the Graduate School office the intention to receive an advanced degree in May.
1-3	Monday-Wednesday—Drop/Add continues for dropping course/seminar registration and adding equivalent units of ungraded research or residence.
3	Wednesday—Final date for dropping course/seminar registration and adding equivalent units of ungraded research or residence.

March
4	Friday—Spring recess begins.
14	Monday—Classes resume.
28-29	Monday-Tuesday—Registration for fall semester 1988, and beginning of registration for summer 1988.

April
1	Friday—Final date for submitting dissertation for the Ph.D. degree.
15	Friday—Final date for submitting theses for master's degrees.
15	Friday—Spring semester classes end.
16-24	Saturday-Sunday—Graduate reading period; length of 200-level course reading period is determined by the instructor.
25	Monday—Final examinations begin.
30	Saturday—Final examinations end.

May
7	Saturday—Commencement begins.
8	Sunday—Graduation exercises. Conferring of degrees.

University Administration

General Administration

H. Keith H. Brodie, M.D., *President*
Phillip A. Griffiths, Ph.D., *Provost*
William G. Anlyan, M.D., D.Sc., *Chancellor for Health Affairs*
Eugene J. McDonald, LL.M., *Senior Vice-President, Administration, and University Counsel*
Joel L. Fleishman, LL.M., *Vice-President*
J. Peyton Fuller, A.B., *Vice-President, Planning and Treasurer*
William J. Griffith, A.B., *Vice-President for Student Affairs*
John J. Piva, Jr., B.A., *Vice-President for Alumni Affairs and Development*
Patricia C. Skarulis, M.A., *Vice-President for Information Systems*
John F. Adcock, M.B.A., *Corporate Controller*
Allison Haltom, A.B., *Secretary of the University*
Charles T. Clotfelter, Ph.D., *Vice-Chancellor of the University*
Andrew G. Wallace, M.D., *Vice-Chancellor for Health Affairs*

Graduate School Administration

Malcolm Gillis, Ph.D., *Dean of the Graduate School*
A. Leigh DeNeef, Ph.D., *Associate Dean*
Donna Lee Giles, A.B., *Assistant Dean*
Katharine Pfeiffer, M.A., *Assistant Dean*
Aleane G. Webb, *Assistant Dean*

Executive Committee of the Graduate Faculty

Dean Malcolm Gillis
Steven Baldwin
Peter Burian
Jeffrey R. Dawson
Carl Erickson
Robert Gleckner
Herbert Hacker
Stanley Hauerwas
Robert Hochmuth
Peter Lange
Henry Petroski
Lewis Siegel
Kathleen Smith
Bruce Wardropper
E. Roy Weintraub
Henry M. Wilbur
Charles Young

Graduate School Faculty

(As of November 1, 1986.)

The date denotes the first year of service at Duke University.

John Lloyd Abernethy (1984), M.D., Ph.D., *Assistant Professor of Pathology*
Mohamed Bahie Abou-Donia (1975), Ph.D., *Professor of Pharmacology*
Dolph O. Adams (1972), M.D., Ph.D., *Professor of Pathology and Associate Professor of Immunology*
David B. Adcock (1983), J.D., *Adjunct Assistant Professor of Health Administration*
Irving E. Alexander (1963), Ph.D., *Professor of Psychology*
Ralph J. Alig (1986), Ph.D., *Adjunct Assistant Professor of Forest Economics*
William K. Allard (1975), Ph.D., *Professor of Mathematics*
A. Tilo Alt (1961-65; 1967), Ph.D., *Associate Professor of Germanic Languages and Literature*
D. Bernard Amos (1962), M.D., *James B. Duke Professor of Immunology*
Carl L. Anderson (1955), Ph.D., *Professor of English*
Nels C. Anderson (1966), Ph.D., *Associate Professor of Physiology*
Page A. W. Anderson (1973), M.D., *Assistant Professor of Physiology*
Edna Andrews (1984), Ph.D., *Assistant Professor of Slavic Languages and Literatures*
Janis Antonovics (1970), Ph.D., *Professor of Botany*
James W. Applewhite (1971), Ph.D., *Associate Professor of English*
Mahadev L. Apte (1965), Ph.D., *Associate Professor of Anthropology*
Yair Argon (1984), Ph.D., *Assistant Professor of Immunology*
Edward M. Arnett (1980), Ph.D., *R. J. Reynolds Industries Professor of Chemistry*
William Louis Ascher (1984), Ph.D., *Professor of Public Policy Studies and Professor of Political Science*
Kurt W. Back (1959), Ph.D., *James B. Duke Professor of Sociology*
Lloyd Richard Bailey (1971), Ph.D., *Associate Professor of Old Testament*
Paul A. Baker (1981), Ph.D., *Assistant Professor of Geology*
Andrew E. Balber (1983), Ph.D., *Assistant Medical Research Professor of Immunology*
Steven W. Baldwin (1970), Ph.D., *Associate Professor of Chemistry*
Helmy Hamdollah Baligh (1967), Ph.D., *Professor of Business Administration*
Robert H. Ballantyne (1962), Ed.D., *Associate Professor of Education*
Bruce W. Ballard (1981), Ph.D., *Associate Professor of Computer Science*
James David Barber (1972), Ph.D., *James B. Duke Professor of Political Science and Professor of Public Policy Studies*
Richard T. Barber (1970), Ph.D., *Professor of Zoology and Professor of Botany*
Thomas Barnett-Robisheaux (1984), Ph.D., *Assistant Professor of History*
Roger C. Barr (1969), Ph.D., *Professor of Biomedical Engineering*
Elizabeth C. Bartlet (1982), Ph.D., *Assistant Professor of Music*

Robert Charles Bartlett (1976), M.A., *Professor of Physical Therapy*
Jorge Valls Bartolome (1978), Ph.D., *Assistant Medical Research Professor of Pharmacology*
Deepak Bastia (1979), Ph.D., *Professor of Microbiology*
Robert H. Bates (1985), Ph.D., *Henry R. Luce Professor of Political Science*
Joseph Battle (1970), Ph.D., *Associate Professor of Business Administration*
Gilbert Baumann (1976), Dr. Sc., *Assistant Medical Research Professor of Physiology*
James R. Baumgardner (1985), Ph.D., *Assistant Professor of Economics*
J. Thomas Beale (1983), Ph.D., *Professor of Mathematics*
Hie Ping Beall (1975), Ph.D., *Assistant Medical Research Professor of Anatomy*
Robert D. Behn (1973), Ph.D., *Associate Professor of Public Policy Studies*
Robert Paul Behringer (1982), Ph.D., *Associate Professor of Physics*
Adrian Bejan (1984), Ph.D., *Professor of Mechanical Engineering and Materials Science*
David F. Bell III (1983), Ph.D., *Assistant Professor of Romance Languages*
Joanne M. Bell (1985), Ph.D., *Assistant Medical Research Professor of Pharmacology*
Robert M. Bell (1972), Ph.D., *Professor of Biochemistry*
Peter Brian Bennett (1972), Ph.D., *Associate Professor of Physiology*
Charles W. Bergquist (1972), Ph.D., *Professor of History*
William Lee Berry (1985), Ph.D., *Adjunct Associate Professor of Health Administration*
James R. Bettman (1982), Ph.D., *Burlington Industries Professor of Business Administration*
William Bevan (1974), Ph.D., *William Preston Few Professor of Psychology*
L. C. Biedenharn, Jr. (1961), Ph.D., *Professor of Physics*
Alan Biermann (1974), Ph.D., *Professor of Computer Science*
Darell D. Bigner (1972), M.D., Ph.D., *Professor of Pathology*
Sandra H. Bigner (1977), M.D., *Associate Professor of Pathology*
Edward George Bilpuch (1962), Ph.D., *Professor of Physics*
Daniel E. Binkley (1982), Ph.D., *Assistant Professor of Forest Ecology*
Mrinmay Biswas (1983), Ph.D., *Associate Professor of Civil Engineering*
Perry J. Blackshear (1985), M.D., Ph.D., *Assistant Professor of Biochemistry*
Kalman P. Bland (1973), Ph.D., *Associate Professor of Religion*
Donald Bliss (1985), Ph.D., *Associate Professor of Mechanical Engineering and Materials Science*
Sherman Bloomer (1983), Ph.D., *Assistant Professor of Geology*
J. J. Blum (1962), Ph.D., *James B. Duke Professor of Physiology*
John A. Board, Jr. (1986), Ph.D., *Assistant Professor of Electrical Engineering and Assistant Professor
    of Computer Science*
Mary T. Boatwright (1979), Ph.D., *Associate Professor of Classical Studies*
Dani P. Bolognesi (1971), Ph.D., *Professor of Virology*
Celia Bonaventura (1972), Ph.D., *Associate Professor of Physiology*
Joseph Bonaventura (1972), Ph.D., *Associate Professor of Physiology*
William James Booth (1985), Ph.D., *Assistant Professor of Political Science*
Frank Borchardt (1971), Ph.D., *Associate Professor of Germanic Languages and Literature*
Lloyd J. Borstelmann (1953), Ph.D., *Professor of Psychology*
Edward H. Bossen (1972), M.D., *Professor of Pathology*
Stephen G. Boyce (1981), Ph.D., *Adjunct Professor of Natural Resources*
John E. Boynton (1968), Ph.D., *Professor of Botany*
William D. Bradford (1966), M.D., *Professor of Pathology*
Ralph Braibanti (1953), Ph.D., *James B. Duke Professor of Political Science*
Eleanor F. Branch (1972), Ph.D., *Associate Professor of Physical Therapy*
Robert N. Brandon (1979), Ph.D., *Andrew W. Mellon Associate Professor of Philosophy*
Douglas T. Breeden (1985), Ph.D., *Assistant Professor of Economics*
Philip L. Brock (1982), Ph.D., *Assistant Professor of Economics*
Arnold Ralph Brody (1978), Ph.D., *Adjunct Assistant Professor of Pathology*
Samuel C. Brown (1983), M.E.A., *Adjunct Assistant Professor of Health Administration*
Caroline A. Bruzelius (1981), Ph.D., *Andrew W. Mellon Assistant Professor of Art History*
James D. Bryers (1984), Ph.D., *Associate Professor of Civil and Environmental Engineering*
C. Edward Buckley III (1963), M.D., *Assistant Professor of Microbiology and Immunology*
Rebecca Buckley (1968), M.D., *Professor of Immunology*
Louis J. Budd (1952), Ph.D., *James B. Duke Professor of English*
M. Vickers Burdett (1977), Ph.D., *Assistant Medical Research Professor of Microbiology*
Donald S. Burdick (1962), Ph.D., *Associate Professor of Mathematics and Associate Professor of Bio-
    medical Engineering*
Peter C. Burger (1973), M.D., *Associate Professor of Pathology*
Peter Burian (1968), Ph.D., *Associate Professor of Classical Studies*
Marian Burke (1982), Ph.D., *Assistant Professor of Business Administration*
Richard M. Burton (1970), D.B.A., *Professor of Business Administration*
Ronald Richard Butters (1967), Ph.D., *Associate Professor of English*
Gale H. Buzzard (1957), Ph.D., *Assistant Professor of Mechanical Engineering*
Edwin H. Cady (1973), Ph.D., *Andrew W. Mellon Professor in the Humanities*

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Clark R. Cahow (1960), Ph.D., *Professor in the Faculty of Arts and Sciences, History*
Dennis M. Campbell (1982), Ph.D., *Professor of Theology*
Ted Allen Campbell (1986), Ph.D., *Assistant Professor of Religion*
Enrico Mario Camporesi (1977), M.D., *Assistant Professor of Physiology*
Nell Cant (1978), Ph.D., *Assistant Professor of Anatomy*
Peter F. Carbone (1966), Ed.D., *Associate Professor of Education*
Marc Caron (1983), Ph.D., *Associate Professor of Physiology*
Christopher R. Carroll (1981), Ph.D., *Assistant Professor of Electrical Engineering*
Robert C. Carson (1960), Ph.D., *Professor of Psychology*
Reginald D. Carter (1971), Ph.D., *Adjunct Assistant Professor of Physiology*
Matt Cartmill (1969), Ph.D., *Professor of Anatomy and Professor of Anthropology*
Ernesto Caserta (1970), Ph.D., *Associate Professor of Romance Languages*
H. Craig Casey, Jr. (1979), Ph.D., *Professor of Electrical Engineering*
John H. Casseday (1972), Ph.D., *Adjunct Associate Professor of Psychology*
David Castriota (1985), Ph.D., *Assistant Professor of Art History*
John Cell (1962), Ph.D., *Professor of History*
Jack B. Chaddock (1966), Sc.D., *Professor of Mechanical Engineering*
William Chafe (1971), Ph.D., *Professor of History*
Jagdish Chandra (1974), Ph.D., *Adjunct Professor of Mathematics*
Margaret Cheney (1984), Ph.D., *Assistant Professor of Mathematics*
Donald B. Chesnut (1965), Ph.D., *Professor of Chemistry*
Norman L. Christensen, Jr. (1973), Ph.D., *Associate Professor of Botany and Associate Professor of Forestry*
Mikael Ciftan (1967), Ph.D., *Adjunct Professor of Physics*
Elizabeth Ann Clark (1982), Ph.D., *Professor of Religion*
Howard G. Clark (1968), Ph.D., *Professor of Biomedical Engineering and Professor of Materials Science*
Charles T. Clotfelter (1979), Ph.D., *Professor of Public Policy Studies and Professor of Economics*
John MacKenzie Clum (1966), Ph.D., *Associate Professor of English*
A. W. Coats (1984), Ph.D., *Research Professor of Economics*
Franklin H. Cocks (1972), Sc.D., *Professor of Materials Science*
Kalman J. Cohen (1974), Ph.D., *Distinguished Bank Research Professor and Professor of Business Administration*
John D. Coie (1968), Ph.D., *Professor of Psychology*
Joel Colton (1947), Ph.D., *Professor of History*
William K. Condrell (1982), J.D., *Adjunct Professor of Forestry*
William E. Conner (1979), Ph.D., *Assistant Professor of Zoology*
Philip J. Cook (1973), Ph.D., *Professor of Public Policy Studies and Professor of Economics*
Joseph M. Corless (1972), M.D., Ph.D., *Associate Professor of Anatomy*
Roger J. Corless (1970), Ph.D., *Associate Professor of Religion*
Ronald B. Corley (1977), Ph.D., *Associate Professor of Immunology*
Bruce Hayward Corliss (1984), Ph.D., *Associate Professor of Geology*
Philip R. Costanzo (1968), Ph.D., *Professor of Psychology*
Martin Joseph Costello III (1975), Ph.D., *Assistant Professor of Anatomy*
John D. Costlow, Jr. (1959), Ph.D., *Professor of Zoology*
Sheila J. Counce (1968), Ph.D., *Professor of Anatomy*
James D. Crapo (1986), Ph.D., *Assistant Professor of Pathology*
Peter Cresswell (1973), Ph.D., *Professor of Immunology*
Herbert F. Crovitz (1963), Ph.D., *Adjunct Professor of Psychology*
Alvin L. Crumbliss (1970), Ph.D., *Professor of Chemistry*
Chicita F. Culberson (1971), Ph.D., *Adjunct Professor of Botany*
William Louis Culberson (1955), Ph.D., *Hugo L. Blomquist Professor of Botany*
David L. Cusic (1980), M.H.A., M.P.H., *Adjunct Assistant Professor of Health Administration*
Ronald Y. Cusson (1970), Ph.D., *Professor of Physics*
David G. Davies (1961), Ph.D., *Professor of Economics*
Calvin D. Davis (1962), Ph.D., *Professor of History*
James Norman Davis (1972), M.D., *Associate Professor of Pharmacology*
Lucy T. Davis (1969), Ed.D., *Associate Professor of Education*
Richard L. Davis (1983), Ph.D., *Assistant Professor of History*
Jeffrey R. Dawson (1972), Ph.D., *Associate Professor of Immunology*
Eugene Davis Day (1962), Ph.D., *Professor of Immunology*
Ruth S. Day (1978), Ph.D., *Associate Professor of Psychology*
Frank C. De Lucia (1969), Ph.D., *Professor of Physics*
Neil Barry de Marchi (1971-80; 1983), Ph.D., *Professor of Economics*
A. Leigh DeNeef (1969), Ph.D., *Associate Professor of English*
Vincent W. Dennis (1973), M.D., *Assistant Professor of Physiology*
Irving T. Diamond (1958), Ph.D., *James B. Duke Professor of Psychology, Professor of Physiology, and Lecturer in Anatomy*

Joseph Di Bona (1967), Ph.D., *Associate Professor of Education*
Michael P. Dieter (1986), Ph.D., *Adjunct Professor of Ecotoxicology*
Richard T. Di Giulio (1982), Ph.D., *Assistant Professor of Ecotoxicology*
Arlene J. Diosegy (1984), J.D., *Adjunct Assistant Professor of Health Administration*
Arif Dirlik (1971), Ph.D., *Associate Professor of History*
Theodore H. Dix (1984), Ph.D., *Assistant Professor of Psychology*
Apostolos Dollas (1986), Ph.D., *Assistant Professor of Electrical Engineering*
Virginia R. Domínguez (1979), Ph.D., *Assistant Professor of Anthropology*
William J. Donelan (1982), M.S., *Adjunct Assistant Professor of Health Administration*
Fenner Douglass (1974), M.Mus., *Professor of Music*
Earl H. Dowell (1983), Sc.D., *Professor of Mechanical Engineering*
John W. Drake (1980), Ph.D., *Adjunct Professor in the Genetics Program*
Bernard I. Duffey (1963), Ph.D., *Professor of English*
Joanne Bechta Dugan (1985), Ph.D., *Assistant Professor of Computer Science and Research Assistant Professor of Electrical Engineering*
Pamela W. Duncan (1979), M.A.C.T., *Assistant Professor of Physical Therapy*
Robert F. Durden (1952), Ph.D., *Professor of History*
George F. Dutrow (1976), Ph.D., *Professor of Forestry*
Carol O. Eckerman (1972), Ph.D., *Associate Professor of Psychology*
David M. Eddy (1981), M.D., Ph.D., *Professor of Public Policy Studies and Professor of Community and Family Medicine*
Julie A. Edell (1981), Ph.D., *Assistant Professor of Business Administration*
Leah Edelstein-Keshet (1984), Ph.D., *Lecturer in Mathematics*
Eric L. Effmann (1977), M.D., *Associate Professor of Anatomy*
Jane G. Elchlepp (1960), M.D., Ph.D., *Associate Professor of Pathology*
Albert Eldridge (1970), Ph.D., *Associate Professor of Political Science*
Everett H. Ellinwood, Jr. (1966), M.D., *Professor of Pharmacology*
Carla S. Ellis (1986), Ph.D., *Associate Professor of Computer Science*
Sharyn Endow (1978), Ph.D., *Associate Professor of Microbiology and Immunology*
Peter C. English (1978), M.D., Ph.D., *Assistant Professor of History*
Robert M. Entman (1980), Ph.D., *Assistant Professor of Public Policy Studies and Assistant Professor of Political Science*
Ann W. Epstein (1979), Ph.D., *Associate Professor of Art History*
Carl J. Erickson (1966), Ph.D., *Professor of Psychology*
Harold P. Erickson (1970), Ph.D., *Professor of Anatomy*
Robert P. Erickson (1961), Ph.D., *Professor of Psychology and Associate Professor of Physiology*
E. Harvey Estes, Jr. (1953), M.D., *Professor of Health Administration*
Lawrence E. Evans (1963), Ph.D., *Professor of Physics*
Janet J. Ewald (1984), Ph.D., *Assistant Professor of History*
Richard B. Fair (1981), Ph.D., *Professor of Electrical Engineering*
Henry A. Fairbank (1962), Ph.D., *Professor of Physics*
David J. Falcone (1975), M.H.A., Ph.D., *Associate Professor of Health Administration*
John Morton Fein (1950), Ph.D., *Professor of Romance Languages*
Michael T. Ferejohn (1983), Ph.D., *Assistant Professor of Philosophy*
Oliver W. Ferguson (1957), Ph.D., *Professor of English*
Bernard F. Fetter (1951), M.D., *Professor of Pathology*
Olivera J. Finn (1982), Ph.D., *Assistant Professor of Immunology*
Peter G. Fish (1969), Ph.D., *Professor of Political Science*
Stanley Fish (1985), Ph.D., *Arts and Sciences Professor of English*
David Fitzpatrick (1983), Ph.D., *Assistant Professor of Anatomy*
Joel Fleishman (1971), LL.M., *Professor of Public Policy Studies and Professor of Law*
Donald J. Fluke (1958), Ph.D., *Professor of Zoology*
John D. Forsyth (1978), D.B.A., *Professor of Business Administration*
Lloyd R. Fortney (1964), Ph.D., *Associate Professor of Physics*
Richard B. Forward (1971), Ph.D., *Associate Professor of Zoology*
Richard G. Fox (1968), Ph.D., *Professor of Anthropology*
Bertram O. Fraser-Reid (1983), Ph.D., *James B. Duke Professor of Chemistry*
Karen Z. Frenzel (1986), Ph.D., *Research Assistant Professor of Electrical Engineering*
Irwin Fridovich (1958), Ph.D., *James B. Duke Professor of Biochemistry*
Jane Marie Gaines (1982), Ph.D., *Assistant Professor of English*
Thomas M. Gallie, Jr. (1954-55; 1956), Ph.D., *Professor of Computer Science*
Miguel Garci-Gómez (1973), Ph.D., *Professor of Romance Languages*
Carl L. Gardner (1986), Ph.D., *Assistant Professor of Computer Science and Assistant Professor of Mathematics*
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Devendra P. Garg (1972) Ph.D., *Professor of Mechanical Engineering*

David Barry Gaspar (1983), Ph.D., *Associate Professor of History*
Raymond Gavins (1970), Ph.D., *Associate Professor of History*
Linda K. George (1976), Ph.D., *Associate Professor of Sociology*
Rhett Truesdale George, Jr. (1957), Ph.D, *Assistant Professor of Electrical Engineering*
Gerald E. Gerber (1962), Ph.D., *Associate Professor of English*
Gary Gereffi (1980), Ph.D., *Associate Professor of Sociology*
John F. Geweke (1983), Ph.D., *Kenan Professor of Economics*
Michael A. Gillespie (1983), Ph.D., *Assistant Professor of Political Science*
Nicholas W. Gillham (1968), Ph.D., *James B. Duke Professor of Zoology*
Bryan Gilliam (1986), Ph.D., *Assistant Professor of Music*
Stephen Malcolm Gillis (1984), Ph.D., *Professor of Public Policy Studies and Professor of Economics*
Kenneth E. Glander (1975), Ph.D., *Associate Professor of Anthropology*
Robert F. Gleckner (1978), Ph.D., *Professor of English*
Rona Goffen (1978), Ph.D., *Professor of Art History*
Martin P. Golding (1976), Ph.D., *Professor of Philosophy*
Craufurd Goodwin (1962), Ph.D., *James B. Duke Professor of Economics*
Lawrence C. Goodwyn (1971), Ph.D., *Associate Professor of History*
George D. Gopen (1985), Ph.D., *Assistant Professor of English*
Andrew Gordon (1985), Ph.D., *Assistant Professor of History*
Ulrich M. Gösele (1984), Ph.D., *Professor of Mechanical Engineering*
Alfred T. Goshaw (1973), Ph.D., *Professor of Physics*
Henry G. Grabowski (1972), Ph.D., *Professor of Economics*
Daniel A. Graham (1969), Ph.D., *Professor of Economics*
Doyle G. Graham (1970), M.D., Ph.D., *Professor of Pathology*
Ronald C. Greene (1958), Ph.D., *Associate Professor of Biochemistry*
Joseph C. Greenfield (1962), M.D., *Associate Professor of Physiology*
Arno L. Greenleaf (1977), Ph.D., *Associate Professor of Biochemistry*
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John W. Gutknecht (1969), Ph.D., *Professor of Physiology*
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Herbert Hacker, Jr. (1965), Ph.D., *Associate Professor of Electrical Engineering*
Warren G. Hall (1982), Ph.D., *Professor of Psychology*
William C. Hall (1970), Ph.D., *Professor of Anatomy and Adjunct Professor of Psychology*
Thomas Alan Hamilton (1982), Ph.D. *Associate Medical Research Professor of Pathology*
William E. Hammond (1968), Ph.D., *Professor of Biomedical Engineering*
Moo-Young Han (1967), Ph.D., *Professor of Physics*
Stuart Handwerger (1971), M.D., *Assistant Professor of Physiology*
Charles Morgan Harman (1961), Ph.D., *Professor of Mechanical Engineering*
Stanley Hauerwas (1984), Ph.D., *Professor of Theological Ethics*
Thomas M. Havrilesky (1969), Ph.D., *Professor of Economics*
Barton Ford Haynes (1980), M.D., *Assistant Professor of Immunology*
Robert G. Healy (1985), Ph.D., *Adjunct Associate Professor of Forestry and Environmental Studies*
James M. Henderson (1986), Ph.D., *Research Professor of Economics*
Robert William Henkens (1968), Ph.D., *Associate Professor of Chemistry*
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C. John Herington (1987), M.A., *Arts and Sciences Professor of Classical Studies*
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Cynthia B. Herrup (1984), Ph.D., *Assistant Professor of History*
Michael Steven Hershfield (1976), M.D., *Associate Professor of Biochemistry*
Frederick Herzog (1960), Th.D., *Professor of Systematic Theology*
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Robert L. Hill (1961), Ph.D., *James B. Duke Professor of Biochemistry*
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Robert M. Hochmuth (1978), Ph.D., *Professor of Biomedical Engineering*
Richard Earl Hodel (1965), Ph.D., *Associate Professor of Mathematics*
Peter C. Holland (1986), Ph.D., *Associate Professor of Psychology*
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Mark A. Holliday (1986), *Assistant Professor of Computer Science*
Ole R. Holsti (1974), Ph.D., *George V. Allen Professor of Political Science*
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Calvin R. Howell (1984), Ph.D., *Assistant Professor of Physics*
Tao-shih Hsieh (1981), Ph.D., *Associate Professor of Biochemistry*
Joel C. Huber (1978), Ph.D., *Associate Professor of Business Administration*
Alexander Hull (1962), Ph.D., *Associate Professor of Romance Languages*
William F. Hyde (1979), Ph.D., *Associate Professor of Forestry and Environmental Studies*
William L. Hylander (1971), Ph.D., *Professor of Anatomy and Associate Professor of Anthropology*
Raymond E. Ideker (1978), M.D., Ph.D., *Associate Professor of Pathology*
Kathryn N. Jackson (1982), Ph.D., *Assistant Professor of Philosophy*
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Thomas C. Johnson (1983), Ph.D., *Associate Professor of Geology*
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William H. Johnston (1983), B.B.A., *Adjunct Assistant Professor of Health Administration*
William W. Johnston (1963), M.D., *Professor of Pathology*
William Thomas Joines (1966), Ph.D., *Professor of Electrical Engineering*
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Jeffrey A. Karson (1985), Ph.D., *Associate Professor of Geology*
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Gershon Kedem (1985), Ph.D., *Associate Professor of Computer Science*
Jack D. Keene (1979), Ph.D., *Associate Professor of Virology*
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Alan C. Kerckhoff (1958), Ph.D., *Professor of Sociology*
Robert B. Kerr (1965), Ph.D., *Professor of Electrical Engineering*
Clinton Donald Kilts (1981), Ph.D., *Assistant Professor of Pharmacology*
Kent P. Kimbrough (1981), Ph.D., *Associate Professor of Economics*
Norman Kirshner (1956), Ph.D., *Professor of Pharmacology*
Joseph Weston Kitchen, Jr. (1962), Ph.D., *Associate Professor of Mathematics*
Herbert P. Kitschelt (1984), Ph.D., *Assistant Professor of Political Science*
Gordon K. Klintworth (1964), M.D., Ph.D., *Professor of Pathology*
Peter H. Klopfer (1958), Ph.D., *Professor of Zoology*
Josiah Doss Knight (1985), Ph.D., *Assistant Professor of Mechanical Engineering*
Kenneth R. Knoerr (1961), Ph.D., *Professor of Forest Meteorology and Associate Professor of Botany*
John A. Koepke (1979), M.D., *Professor of Pathology*
Bruce D. Kohorn (1986), Ph.D., *Assistant Professor of Botany*
J. Mailen Kootsey (1971-76; 1979), Ph.D., *Associate Professor of Physiology and Research Associate Professor of Computer Science*
Allan Kornberg (1965), Ph.D., *Professor of Political Science*
Wesley A. Kort (1965), Ph.D., *Professor of Religion*
David Paul Kraines (1970), Ph.D., *Associate Professor of Mathematics*
Wilmer L. Kranich (1986), Ph.D., *Adjunct Professor of Civil and Environmental Engineering*
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Cynthia Moreton Kuhn (1978), Ph.D., *Associate Professor of Pharmacology*
Bruce R. Kuniholm (1977), Ph.D., *Associate Professor of Public Policy Studies and Associate Professor of History*
Thomas A. Kunkel (1986), Ph.D., *Adjunct Assistant Professor in the Genetics Program*
Johannes A. Kylstra (1965), M.D., Ph.D., *Associate Professor of Physiology*
Leon Lack (1965), Ph.D., *Professor of Pharmacology*
Creighton Lacy (1953), Ph.D., *Professor of World Christianity*
Helen F. Ladd (1986), Ph.D., *Professor of Public Policy Studies and Adjunct Professor of Economics*
Martin Lakin (1958), Ph.D., *Professor of Psychology*
Michael K. Lamvik (1982), Ph.D., *Assistant Professor of Anatomy*
Kenneth C. Land (1985), Ph.D., *Professor of Sociology*
Peter Lange (1982), Ph.D., *Associate Professor of Political Science*
Thomas A. Langford (1956), Ph.D., *Professor of Systematic Theology*
Daniel M. Lapadula (1981), Ph.D., *Assistant Medical Research Professor of Pharmacology*
Dan Laughhunn (1968-75; 1976), D.B.A., *Professor of Business Administration*
Cathy C. Laurie-Ahlberg (1986), Ph.D., *Associate Professor of Zoology*
Gregory F. Lawler (1979), Ph.D., *Associate Professor of Mathematics*
Bruce B. Lawrence (1971), Ph.D., *Professor of Religion*
Richard H. Leach (1955), Ph.D., *Professor of Political Science*
Robert Lefkowitz (1973), M.D., *Professor of Biochemistry*
Ann LeFurgey (1980), Ph.D., *Assistant Professor of Physiology*
Frank Lentricchia (1984), Ph.D., *Professor of English*
Warren Lerner (1961), Ph.D. *Professor of History*
Arie Y. Lewin (1974), Ph.D., *Professor of Business Administration*
Melvyn Lieberman (1968), Ph.D., *Professor of Physiology*
Chia-Sheng Lin (1981), Ph.D., *Assistant Professor of Anatomy*
C. Eric Lincoln (1976), Ph.D., *Professor of Sociology of Religion*
Frederick W. Lindahl (1985), Ph.D., *Assistant Professor of Economics*
Elwood A. Linney (1984), Ph.D., *Associate Professor of Microbiology and Immunology*
Joseph Lipscomb, Jr. (1974), Ph.D., *Associate Professor of Public Policy Studies*
Daniel A. Livingstone (1956), Ph.D., *James B. Duke Professor of Zoology*
John E. Lochman (1984), Ph.D., *Adjunct Assistant Professor of Psychology*
Charles H. Lochmüller (1969), Ph.D., *Professor of Chemistry and Professor of Biochemical Engineering*
Gregory R. Lockhead (1965), Ph.D., *Professor of Psychology*
Timothy J. Lomperis (1984), Ph.D., *Assistant Professor of Political Science*
Charles Houston Long (1974), Ph.D., *Professor of Religion*
William Longley (1968), Ph.D., *Associate Professor of Anatomy*
Donald W. Loveland (1973), Ph.D., *Professor of Computer Science*
John Charles Lucchesi (1980), Ph.D., *Adjunct Professor in the Genetics Program*
John G. Lundberg (1970), Ph.D., *Associate Professor of Zoology*
John M. McCann (1978), Ph.D., *Associate Professor of Business Administration*
Kevin F. McCardle (1985), Ph.D., *Assistant Professor of Business Administration*
Kenneth S. McCarty (1959), Ph.D., *Professor of Biochemistry*
Kenneth Scott McCarty, Jr. (1976), M.D., Ph.D., *Associate Professor of Pathology*
David R. McClay (1973), Ph.D., *Professor of Zoology and Assistant Professor of Immunology*
John B. McConahay (1974), Ph.D., *Associate Professor of Public Policy Studies*
James H. McElhaney (1973), Ph.D., *Professor of Biomedical Engineering*
Marjorie McElroy (1970), Ph.D., *Professor of Economics*
Philip A. McHale (1972), Ph.D., *Adjunct Assistant Professor of Physiology*
Thomas J. McIntosh (1977), Ph.D., *Associate Professor of Anatomy*
Margaret A. McKean (1974), Ph.D., *Associate Professor of Political Science*
Thomas J. McManus (1961), M.D., *Associate Professor of Physiology*
James O. McNamara (1973), M.D., *Associate Professor of Pharmacology*
Andrew T. McPhail (1968), Ph.D., *Professor of Chemistry*
Richard A. MacPhail (1984), Ph.D., *Assistant Professor of Chemistry*
Ross D. E. MacPhee (1979), Ph.D., *Associate Professor of Anatomy*
George L. Maddox, Jr. (1960), Ph.D., *Professor of Sociology*
Wesley A. Magat (1974), Ph.D., *Associate Professor in Fuqua School of Business and Associate Professor of Public Policy Studies*
Lynn A. Maguire (1982), Ph.D., *Assistant Professor of Resource Ecology*
Edward P. Mahoney (1965), Ph.D., *Professor of Philosophy*
Lazaro J. Mandel (1972), Ph.D., *Professor of Physiology*
Kenneth G. Manton (1977), Ph.D., *Research Professor of Demographic Studies*

Carlos M. Marin (1982), Ph.D., *Assistant Professor of Hydrology and Assistant Professor of Civil and Environmental Engineering*

Peter N. Marinos (1968), Ph.D., *Professor of Electrical Engineering and Professor of Computer Science*

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Gail R. Marsh (1969), Ph.D., *Lecturer in Psychology*

Robert C. Marshall (1983), Ph.D., *Assistant Professor of Economics*

Anne L. Martin (1984), Ph.D., *Assistant Professor of Health Administration*

Hisham Z. Massoud (1983), Ph.D., *Assistant Professor of Electrical Engineering*

Seymour Mauskopf (1964), Ph.D., *Professor of History*

Joseph B. Mazzola (1984), Ph.D., *Assistant Professor of Business Administration*

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Elgin W. Mellown, Jr. (1965), Ph.D., *Associate Professor of English*

Robert J. Melosh (1978), Ph.D., *Professor of Civil Engineering*

Daniel B. Menzel (1971), Ph.D., *Professor of Pharmacology*

Richard S. Metzgar (1962), Ph.D., *Professor of Immunology*

Michael J. Meurer (1985), Ph.D., *Assistant Professor of Economics*

Johannes Horst Max Meyer (1959), Ph.D., *Professor of Physics*

Carol L. Meyers (1979), Ph.D., *Associate Professor of Religion*

Eric M. Meyers (1969), Ph.D., *Professor of Religion*

George Michalopoulos (1977), M.D., Ph.D., *Associate Professor of Pathology*

Agnes K. L. Michels (1981), Ph.D., *Visiting Professor of Classical Studies*

Christine E. Miller (1984), Ph.D., *Assistant Professor of Biomedical Engineering*

Martin Miller (1970), Ph.D., *Associate Professor of History*

Sara Elizabeth Miller (1973), Ph.D., *Associate Medical Research Professor of Microbiology*

Elliott Mills (1968), Ph.D., *Professor of Pharmacology and Associate Professor of Physiology*

Brent Drennen Mishler (1984), Ph.D., *Assistant Professor of Botany*

Thomas G. Mitchell (1974), Ph.D., *Associate Professor of Mycology*

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John Kevin Moore (1984), J.D., *Adjunct Assistant Professor of Health Administration*

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Lawrence C. Moore, Jr. (1966), Ph.D., *Associate Professor of Mathematics*

Richard C. Morey (1978), Ph.D., *Professor of the Practice of Management Sciences*

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Bruce J. Muga (1967), Ph.D., *Professor of Civil Engineering*

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Kristen B. Neuschel (1982), Ph.D., *Assistant Professor of History*

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Frederik Nijhout (1977), Ph.D., *Associate Professor of Zoology*

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William M. O'Barr (1969), Ph.D., *Professor of Anthropology*

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David L. Paletz (1967), Ph.D., *Professor of Political Science*

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Sandra P. Robinson (1983), Ph.D., *Assistant Professor of Religion*
Herman R. Robl (1959-64; 1966), Ph.D., *Adjunct Professor of Physics*
Marshall R. Roderick (1985), Ph.D., *Assistant Professor of Philosophy*
Alex Roland (1981), Ph.D., *Associate Professor of History*
James L. Rolleston (1975), Ph.D., *Associate Professor of Germanic Languages and Literature*
Elaine Romanelli (1984), Ph.D., *Assistant Professor of Business Administration*
Donald J. Rose (1984), Ph.D., *Professor of Computer Science and Professor of Mathematics*
Gerald Martin Rosen (1972), Ph.D., *Associate Professor of Pharmacology*
Arnold L. Rosenberg (1981), Ph.D., *Professor of Computer Science*
Jonathan B. Rosenberg (1983), Ph.D., *Research Assistant Professor of Computer Science*
Bruce R. Rosendahl (1976), Ph.D., *Associate Professor of Geology*
Kathleen A. Ross (1984), Ph.D., *Assistant Professor of Romance Languages*
Wendell F. Rosse (1966), M.D., *Professor of Immunology*
Susan Roth (1973), Ph.D., *Associate Professor of Psychology*
Virginia Louise Roth (1983), Ph.D., *Assistant Professor of Zoology*
Jack P. Royer (1978), Ph.D., *Assistant Professor of Forestry and Environmental Studies*
David C. Rubin (1978), Ph.D., *Associate Professor of Psychology*
Joan V. Ruderman (1986), Ph.D., *Associate Professor of Zoology*
Clyde de Loache Ryals (1973), Ph.D., *Professor of English*
Harvey J. Sage (1964), Ph.D., *Associate Professor of Biochemistry and Associate Professor of Immunology*
Edward A. Saibel (1975), Ph.D., *Adjunct Professor of Civil Engineering*
Alfred Paul Sanfilippo (1979), M.D., Ph.D., *Associate Professor of Pathology*
David H. Sanford (1970), Ph.D., *Professor of Philosophy*
Leslie D. Saper (1986), Ph.D., *Assistant Professor of Mathematics*
Jack Murad Sasson (1983), Ph.D., *Adjunct Professor in Religion*
Robert N. Sawyer (1976), Ed.D., *Associate Professor of Education*
Frederick H. Schachat (1977), Ph.D., *Assistant Professor of Anatomy*
David G. Schaeffer (1978), Ph.D., *Professor of Mathematics*
Saul M. Schanberg (1967), M.D., Ph.D., *Professor of Pharmacology*
Susan S. Schiffman (1972), Ph.D., *Adjunct Professor of Psychology*
William H. Schlesinger (1980), Ph.D., *Associate Professor of Botany*
David M. Schlossman (1985), M.D., Ph.D., *Assistant Professor of Biochemistry*
Klaus Schmidt-Koenig (1983), Ph.D., *Adjunct Professor of Zoology*
Chadmark L. Schoen (1982), Ph.D., *Assistant Professor of Mathematics*
Stanley Clifford Schold, Jr. (1978), M.D., *Assistant Professor of Pathology*
David W. Schomberg (1968), Ph.D., *Associate Professor of Physiology*
Rochelle D. Schwartz (1986), Ph.D., *Assistant Professor of Pharmacology*
Anne Firor Scott (1961), Ph.D., *William K. Boyd Professor of History*
William E. Scott (1958), Ph.D., *Professor of History*
Richard A. Scoville (1961), Ph.D., *Associate Professor of Mathematics*
Richard B. Searles (1965), Ph.D., *Professor of Botany*
W. David Sedwick (1976), Ph.D., *Assistant Medical Research Professor of Microbiology*
Tilman Seebass (1977), Ph.D., *Associate Professor of Music*
Hilliard Foster Seigler (1967), M.D., *Professor of Immunology*
Edward J. Shaughnessy, Jr. (1975), Ph.D., *Professor of Mechanical Engineering*
Barbara Ramsay Shaw (1975), Ph.D., *Associate Professor of Chemistry*
John Shelburne (1973), M.D., Ph.D., *Professor of Pathology*
Marion L. Shepard (1967), Ph.D., *Professor of Materials Science*
Blair H. Sheppard (1981), Ph.D., *Associate Professor of Business Administration and lecturer in Psychology*
Sudhir Shetty (1984), Ph.D., *Assistant Professor of Public Policy Studies and Assistant Professor of Economics*
Joseph R. Shoenfield (1952), Ph.D., *Professor of Mathematics*
James N. Siedow (1976), Ph.D., *Associate Professor of Botany*
Lewis M. Siegel (1968), Ph.D., *Professor of Biochemistry*
Alexander Silbiger (1984), Ph.D., *Professor of Music*
Sidney Arthur Simon (1974), Ph.D., *Associate Professor of Physiology*
Elwyn L. Simons (1977), Ph.D., D.Phil., *James B. Duke Professor of Anthropology and Professor of Anatomy*
Ida Harper Simpson (1959), Ph.D., *Professor of Sociology*
William R. Sizemore (1982), Ph.D., *Adjunct Professor of Forestry*

Theodore Alan Slotkin (1971), Ph.D., *Professor of Pharmacology*
Carol A. Smith (1974), Ph.D., *Associate Professor of Anthropology*
Connie U. Smith (1980), Ph.D., *Assistant Professor of Computer Science*
D. Moody Smith (1965), Ph.D., *Professor of New Testament Interpretation*
David A. Smith (1962), Ph.D., *Associate Professor of Mathematics*
Donald S. Smith II (1961), M.H.A., *Assistant Professor of Health Administration*
Grover C. Smith (1952), Ph.D., *Professor of English*
Harmon L. Smith (1959), Ph.D., *Professor of Moral Theology*
Joel Smith (1958), Ph.D., *Professor of Sociology*
Kathleen P. Smith (1980), Ph.D., *Assistant Professor of Anatomy*
Peter Smith (1959), Ph.D., *Professor of Chemistry*
Peter G. Smith (1982), Ph.D., *Assistant Medical Research Professor of Pharmacology*
Ralph Snyderman (1971), M.D., *Professor of Immunology*
George G. Somjen (1963), M.D., *Professor of Physiology*
Joachim R. Sommer (1957), M.D., *Professor of Pathology*
Madison S. Spach (1958), M.D., *Professor of Physiology*
John R. Spencer (1978), Ph.D., *Professor of Art History*
Kenneth I. Spenner (1984), Ph.D., *Associate Professor of Sociology*
Leonard Spicer (1984), Ph.D., *Professor of Biochemistry*
Thomas Arthur Spragens, Jr. (1967), Ph.D., *Professor of Political Science*
Carol B. Stack (1975), Ph.D., *Associate Professor of Public Policy Studies and Adjunct Associate Professor of Anthropology*
John E. R. Staddon (1967), Ph.D., *James B. Duke Professor of Psychology and Professor of Zoology*
Richard Staelin (1982), Ph.D., *Edward and Rose Donnell Professor of Business Administration*
Dale O. Stahl II (1982), Ph.D., *Assistant Professor of Economics*
William J. Stambaugh (1961), Ph.D., *Professor of Forest Pathology*
Dennis Keith Stanley (1961), Ph.D., *Associate Professor of Classical Studies*
Charles Franklin Starmer, Jr. (1966), Ph.D., *Professor of Computer Science*
Deborah A. Steege (1977), Ph.D., *Associate Professor of Biochemistry*
Harold K. Steen (1985), Ph.D., *Adjunct Professor of Forestry and Environmental Studies*
David Curtis Steinmetz (1971), Th.D., *Professor of Church History and Doctrine*
Jens A. Stephan (1984), Ph.D., *Assistant Professor of Business Administration*
Mark Andrew Stern (1985), Ph.D., *Assistant Professor of Mathematics*
Philip Stewart (1972), Ph.D., *Professor of Romance Languages*
Donald E. Stone (1963), Ph.D., *Professor of Botany*
Boyd R. Strain (1969), Ph.D., *Professor of Botany*
Victor H. Strandberg (1966), Ph.D., *Professor of English*
Harold Carl Strauss (1972), M.D., *Associate Professor of Pharmacology*
Richard A Strelitz (1984), Ph.D., *Assistant Professor of Geology*
Howard Austin Strobel (1948), Ph.D., *Professor of Chemistry*
Stephen Strom (1983), Ph.D., *Assistant Medical Research Professor of Pharmacology*
Akio Sugino (1986), Ph.D., *Adjunct Assistant Professor of Genetics*
Judy Sund (1986), Ph.D., *Assistant Professor of Art History*
J. Bolling Sullivan (1970), Ph.D., *Associate Professor of Biochemistry*
John P. Sutherland (1969), Ph.D., *Associate Professor of Zoology*
James A. Swenberg (1979), D.V.M., Ph.D., *Adjunct Associate Professor of Pathology*
John Sylvester (1982), Ph.D., *Assistant Professor of Mathematics*
Avis L. Sylvia (1977), Ph.D., *Associate Medical Research Professor of Physiology*
Daniel B. Szyld (1986), Ph.D., *Assistant Professor of Computer Science*
Teh Yu Tan (1986), Ph.D., *Professor of Materials Science*
Charles Tanford (1960), Ph.D., *James B. Duke Professor of Physiology*
George E. Tauchen (1977), Ph.D., *Associate Professor of Economics*
Kenneth Allen Taylor (1980), Ph.D., *Associate Medical Research Professor of Anatomy*
Robert Taylor (1983), Ph.D., *Professor of Health Administration*
John J. TePaske (1967), Ph.D., *Professor of History*
Marcel Tetel (1960), Ph.D., *Professor of Romance Languages*
John E. Thomas (1987), Ph.D., *Associate Professor of Physics*
Jean-Jacques Thomas (1981), Doctorat de 3e Cycle, *Associate Professor of Romance Languages*
Jane Thompkins (1985), Ph.D., *Professor of English*
Robert J. Thompson, Jr. (1984), Ph.D., *Adjunct Professor of Psychology*
Fredrick L. Thurstone (1967), Ph.D., *Professor of Biomedical Engineering*
Edward A. Tiryakian (1965), Ph.D., *Professor of Sociology*
R. Larry Todd (1978), Ph.D., *Associate Professor of Music*
Jane Tompkins (1985), Ph.D., *Professor of English*
Robert E. Toomey (1980), LL.D., *Adjunct Professor of Health Administration*
Marianna Torgovnick (1981), Ph.D., *Professor of English*
Edward Tower (1974), Ph.D., *Professor of Economics*

Gregg E. Trahey (1985), Ph.D., *Assistant Professor of Biomedical Engineering*
Vladimir G. Treml (1967), Ph.D., *Professor of Economics*
Kishor S. Trivedi (1975), Ph.D., *Professor of Computer Science and Professor of Electrical Engineering*
Michel-Rolph Trouillot (1984), Ph.D., *Assistant Professor of Anthropology*
George Tsebelis (1986), Ph.D., *Assistant Professor of Political Science*
Anne S. Tsui (1981), Ph.D., *Assistant Professor of Business Administration*
Vance Tucker (1964), Ph.D., *Professor of Zoology*
E. Lee Tyrey (1970), Ph.D., *Associate Professor of Anatomy*
Senol Utku (1970), Sc.D., *Professor of Civil Engineering and Professor of Computer Science*
Marcy K. Uyenoyama (1982), Ph.D., *Associate Professor of Zoology*
Arturo Valenzuela (1970), Ph.D., *Professor of Political Science*
Howard R. Veit (1985), M.A., *Adjunct Assistant Professor of Health Administration*
Stephanos Venakides (1986), Ph.D., *Associate Professor of Mathematics*
John M. Vernon (1966), Ph.D., *Professor of Economics*
P. Aarne Vesilind (1970), Ph.D., *Professor of Civil and Environmental Engineering*
Dan O. Via, Jr. (1984), Ph.D., *Professor of New Testament*
Rytas J. Vilgalys (1986), Ph.D., *Assistant Professor of Botany*
Elia E. Villanueva (1969), A.M., *Associate Professor of Physical Therapy*
F. Stephen Vogel (1961), M.D., *Professor of Pathology*
Steven Vogel (1966), Ph.D., *Professor of Zoology*
Robin T. Vollmer (1975), M.D., *Assistant Clinical Professor of Pathology*
Olaf T. von Ramm (1974), Ph.D., *Professor of Biomedical Engineering*
Robert A. Wagner (1978), Ph.D., *Associate Professor of Computer Science*
Geoffrey Wainwright (1983), Dr.Théol., *Professor of Religion*
Stephen A. Wainwright (1964), Ph.D., *James B. Duke Professor of Zoology*
William D. Walker (1971), Ph.D., *Professor of Physics*
Andrew G. Wallace (1964), M.D., *Assistant Professor of Physiology*
T. Dudley Wallace (1974), Ph.D., *James B. Duke Professor of Economics*
Lise Wallach (1970), Ph.D., *Lecturer in Psychology*
Michael A. Wallach (1962-72; 1973), Ph.D., *Professor of Psychology*
Richard L. Walter (1962), Ph.D., *Professor of Physics*
Paul P. Wang (1968), Ph.D., *Professor of Electrical Engineering*
Calvin L. Ward (1952), Ph.D., *Professor of Zoology*
Frances Ellen Ward (1969), Ph.D., *Professor of Immunology*
Robert E. Ward (1983), B.Mus., *Visiting Mary Duke Biddle Professor of Music and Fellow of the Institute of the Arts*
Bruce W. Wardropper (1962), Ph.D., *William Hanes Wannamaker Professor of Romance Languages*
Seth L. Warner (1955), Ph.D., *Professor of Mathematics*
David Grant Warren (1975), J.D., *Professor of Health Administration*
W. David Watkins (1984), M.D., Ph.D., *Professor of Pharmacology*
Robert E. Webster (1970), Ph.D., *Professor of Biochemistry*
Andrew S. Wechsler (1974), M.D., *Assistant Professor of Physiology*
E. Roy Weintraub (1970), Ph.D., *Professor of Economics*
Morris Weisfeld (1967), Ph.D., *Professor of Mathematics*
Henry R. Weller (1978), Ph.D., *Professor of Physics*
Robert P. Weller (1980), Ph.D., *Assistant Professor of Anthropology*
Richard L. Wells (1962), Ph.D., *Professor of Chemistry*
Robert W. Wheat (1958), Ph.D., *Professor of Microbiology*
Richard A. White (1963), Ph.D., *Professor of Botany*
Richard Whorton (1979), Ph.D., *Associate Professor of Pharmacology*
Carol J. Wikstrand (1975), Ph.D., *Assistant Medical Research Professor of Pathology*
Henry M. Wilbur (1973), Ph.D., *Professor of Zoology*
Robert L. Wilbur (1957), Ph.D., *Professor of Botany*
Pelham Wilder, Jr. (1949), Ph.D., *Professor of Chemistry and Professor of Pharmacology*
William E. Wilkinson (1983), Ph.D., *Associate Professor of Health Administration*
Hilda Pope Willett (1948), Ph.D., *Professor of Microbiology*
George W. Williams (1957), Ph.D., *Professor of English*
Kenny J. Williams (1977), Ph.D., *Professor of English*
Peter Fredric Williams (1985), Ph.D., *Professor of Music*
James F. Wilson (1967), Ph.D., *Professor of Civil Engineering*
John Wilson (1968), D.Phil., *Associate Professor of Sociology*
Steven P. Wilson (1982), Ph.D., *Assistant Medical Research Professor of Pharmacology*
Thomas George Wilson (1959), Sc.D., *Professor of Electrical Engineering*
Wilkie Andrew Wilson, Jr. (1974), Ph.D., *Associate Medical Research Professor of Pharmacology*
Robert G. Winfree (1974), M.A., *Adjunct Associate Professor of Health Administration*
Cliff W. Wing, Jr. (1965), Ph.D., *Professor of Psychology*
Robert L. Winkler (1984), Ph.D., *Professor of Business Administration*

Orval S. Wintermute (1958), Ph.D., *Professor of Religion*
Ronald Witt (1971), Ph.D., *Professor of History*
Benjamin Wittels (1961), M.D., *Professor of Pathology*
Myron L. Wolbarsht (1968), Ph.D., *Professor of Biomedical Engineering and Associate Professor of Physiology*
Robert L. Wolpert (1984), Ph.D., *Assistant Medical Research Professor*
Ronald C. Wong (1985), Ph.D., *Research Assistant Professor of Electrical Engineering*
Peter H. Wood (1975), Ph.D., *Associate Professor of History*
Max A. Woodbury (1966), Ph.D., *Professor of Computer Science*
Donald Wright (1967), Ph.D., *Associate Professor of Mechanical Engineering*
Patricia Chapple Wright (1983), Ph.D., *Visiting Assistant Professor of Anthropology*
Duncan Yaggy (1980), Ph.D., *Professor of Public Management in Public Policy Studies and Adjunct Assistant Professor of Health Administration*
William E. Yarger (1971), M.D., *Assistant Professor of Physiology*
William P. Yohe (1958), Ph.D., *Professor of Economics*
James G. Yoho (1984), Ph.D., *Research Professor of Forest Investment*
Charles R. Young (1954), Ph.D., *Professor of History*
John G. Younger (1974), Ph.D., *Associate Professor of Classical Studies*
Allen Zagarell (1980), Ph.D., *Assistant Professor of Anthropology*
Michael Rod Zalutsky (1986), Ph.D. *Assistant Professor of Pathology*
Gary A. Zarkin (1982), Ph.D., *Assistant Professor of Economics*
Peter Zwadyk, Jr. (1971), Ph.D., *Associate Professor of Pathology*

Emeritus Professors

John Richard Alden (1955), Ph.D., *James B. Duke Professor Emeritus of History*
Lewis Edward Anderson (1936), Ph.D., *Professor Emeritus of Botany*
Roger Fabian Anderson (1950), Ph.D., *Professor Emeritus of Entomology*
Joseph Randle Bailey (1946), Ph.D., *Professor Emeritus of Zoology*
Frank Baker (1960), Ph.D., *Professor Emeritus of English Church History*
M. Margaret Ball (1963), Ph.D., *Professor Emeritus of Political Science*
Katharine May Banham (1946), Ph.D., *Associate Professor Emeritus of Psychology*
Frederick Bernheim (1930), Ph.D., *James B. Duke Professor Emeritus of Pharmacology*
Mary L. C. Bernheim (1930), Ph.D., *Professor Emeritus of Biochemistry*
William Dwight Billings (1952), Ph.D., *James B. Duke Professor Emeritus of Botany*
Cazlyn Green Bookhout (1935), Ph.D., *Professor Emeritus of Zoology*
Benjamin Boyce (1950), Ph.D., *James B. Duke Professor Emeritus of English*
Charles Kilgo Bradsher (1939), Ph.D., *James B. Duke Professor Emeritus of Chemistry*
Martin Bronfenbrenner (1971), Ph.D., *William R. Kenan, Jr. Professor Emeritus of Economics*
Earl Ivan Brown II (1960), Ph.D., *J. A. Jones Professor Emeritus of Civil Engineering*
Frances Campbell Brown (1931), Ph.D., *Professor Emeritus of Chemistry*
Leonard Carlitz (1932), Ph.D., *James B. Duke Professor Emeritus of Mathematics*
William H. Cartwright (1951), Ph.D., *Professor Emeritus of Education*
Frederic N. Cleaveland (1971), Ph.D., *Professor Emeritus of Political Science*
Robert Taylor Cole (1935), Ph.D., *James B. Duke Research Professor Emeritus of Political Science*
Robert Merle Colver (1953), Ed.D., *Associate Professor Emeritus of Education*
Bingham Dai (1943), Ph.D., *Professor Emeritus of Psychology*
William D. Davies (1966), D.D., F.B.A., *George Washington Ivey Professor Emeritus of Advanced Studies and Research in Christian Origins*
Neal Dow (1934), Ph.D., *Professor Emeritus of Romance Languages*
Francis George Dressel (1929), Ph.D., *Professor Emeritus of Mathematics*
Kenneth Lindsay Duke (1940), Ph.D., *Associate Professor Emeritus of Anatomy*
Howard Easley (1930), Ph.D., *Associate Professor Emeritus of Education*
William Whitfield Elliott (1925), Ph.D., *Professor Emeritus of Mathematics*
Ernest Elsevier (1950), M.S., *Associate Professor Emeritus of Mechanical Engineering*
John Wendell Everett (1932), Ph.D., *Professor Emeritus of Anatomy*
Arthur Bowles Ferguson (1939), Ph.D., *Professor Emeritus of History*
Wallace Fowlie (1964), Ph.D., *James B. Duke Professor Emeritus of Romance Languages*
John Hope Franklin (1981), Ph.D., *James B. Duke Professor Emeritus of History*
Ernestine Friedl (1973), Ph.D., *James B. Duke Professor Emeritus of Anthropology*
William J. Furbish (1954), M.S., *Associate Professor Emeritus of Geology*
W. Scott Gehman, Jr. (1954), Ph.D., *Professor Emeritus of Psychology in Education*
Allan H. Gilbert (1920), Ph.D., *Professor Emeritus of English*
Clarence Gohdes (1930), Ph.D., *James B. Duke Professor Emeritus of English*
Walter Gordy (1946), Ph.D., *James B. Duke Professor Emeritus of Physics*
John R. Gregg (1957), Ph.D., *Professor Emeritus of Zoology*

Paul M. Gross (1919), Ph.D., *William Howell Pegram Professor Emeritus of Chemistry*
Kazimierz Grzybowski (1967), S.J.D., *Professor Emeritus of Political Science*
Hugh Marshall Hall, Jr. (1952), Ph.D., *Professor Emeritus of Political Science*
Louise Hall (1931), Ph.D., *Professor Emeritus of Architecture*
John Hamilton Hallowell (1942), Ph.D., *James B. Duke Professor Emeritus of Political Science*
Jerome S. Harris (1936), M.D., *Professor Emeritus of Biochemistry*
William S. Heckscher (1966), Ph.D., *Benjamin N. Duke Professor Emeritus of Art*
Henry Hellmers (1965), Ph.D., *Professor Emeritus of Botany and Professor Emeritus of Forestry*
Stuart C. Henry (1959), Ph.D., *Professor Emeritus of American Christianity*
Marcus Edwin Hobbs (1935), Ph.D., *University Distinguished Service Professor Emeritus of Chemistry*
Everett H. Hopkins (1961), M.A., LL.D., *Professor Emeritus of Education*
Wanda S. Hunter (1947), Ph.D., *Associate Professor Emeritus of Zoology*
Allan S. Hurlburt (1956), Ph.D., *Professor Emeritus of Education*
Marianna Jenkins (1948), Ph.D., *Professor Emeritus of Art*
Bronislas de Leval Jezierski (1958), Ph.D., *Associate Professor Emeritus of Slavic Languages and Literatures*
Terry W. Johnson, Jr. (1954), Ph.D., *Professor Emeritus of Botany*
Brady Rimbey Jordan (1927), Ph.D., *Professor Emeritus of Romance Languages*
Helen L. Kaiser (1943), R.P.T., *Professor Emeritus of Physical Therapy*
Gregory A. Kimble (1952-68; 1977), Ph.D., *Professor Emeritus of Psychology*
Paul Jackson Kramer (1931), Ph.D., *James B. Duke Professor Emeritus of Botany*
Wladyslaw W. Kulski (1963), Ph.D., LL.D., *James B. Duke Professor Emeritus of Russian Affairs*
Weston LaBarre (1946), Ph.D., *James B. Duke Professor Emeritus of Anthropology*
Harold Walter Lewis (1946), Ph.D., *University Distinguished Service Professor Emeritus of Physics*
H. Gregg Lewis (1975), Ph.D., *Profesor Emeritus of Economics*
John L. Lievsay (1962), Ph.D., *James B. Duke Professor Emeritus of English*
L. Sigfred Linderoth, Jr. (1965), M.E., *Professor Emeritus of Mechanical Engineering*
John C. McKinney (1957), Ph.D., *Professor Emeritus of Sociology*
John Nelson Macduff (1956), M.M.E., *Professor Emeritus of Mechanical Engineering*
Sidney David Markman (1947), Ph.D., *Professor Emeritus of Art History and Professor Emeritus of Archaeology*
Earl George Mueller (1945), Ph.D., *Professor Emeritus of Art*
Francis Joseph Murray (1960), Ph.D., *Professor Emeritus of Mathematics*
Aubrey Willard Naylor (1952), Ph.D., *James B. Duke Professor Emeritus of Botany*
Yasuhiko Nozaki (1966), Ph.D., *Associate Emeritus in Biochemistry*
James G. Osborne (1961), B.S., *Professor Emeritus of Forest Biometry*
Harry Ashton Owen, Jr. (1951), Ph.D., *Professor Emeritus of Electrical Engineering*
Harold Talbot Parker (1939), Ph.D., *Professor Emeritus of History*
Lewis Patton (1926), Ph.D., *Professor Emeritus of English*
Ray C. Petry (1937), Ph.D., LL.D., *James B. Duke Professor Emeritus of Church History*
Olan Lee Petty (1952), Ph.D., *Professor Emeritus of Education*
Leland R. Phelps (1961), Ph.D., *Professor Emeritus of Germanic Languages and Literature*
Jane Philpott (1951), Ph.D., *Professor Emeritus of Botany and Professor Emeritus of Wood Anatomy*
Richard Lionel Predmore (1950), D.M.L., *Professor Emeritus of Romance Languages*
Jack J. Preiss (1959), Ph.D., *Professor Emeritus of Sociology*
Richard A. Preston (1965), Ph.D., *William K. Boyd Professor Emeritus of History*
James Ligon Price, Jr. (1952), *Professor Emeritus of Religion*
Louis DuBose Quin (1957), Ph.D., *James B. Duke Professor Emeritus of Chemistry*
Theodore Ropp (1938), Ph.D., *Professor Emeritus of History*
Mabel F. Rudisill (1948), Ph.D., *Associate Professor Emeritus of Education*
Charles Richard Sanders (1937), Ph.D., *Professor Emeritus of English*
Lloyd Saville (1946), Ph.D., *Professor Emeritus of Economics*
Harold Schiffman (1963), Ph.D., *Professor Emeritus of Psychology*
Knut Schmidt-Nielsen (1952), Ph.D., *Professor Emeritus of Physiology and Zoology*
William H. Simpson (1930), Ph.D., *Professor Emeritus of Political Science*
Joseph John Spengler (1934), Ph.D., *James B. Duke Professor Emeritus of Economics*
William Franklin Stinespring (1936), Ph.D., *Professor Emeritus of Old Testament and Semitics*
W. A. Stumpf (1948), Ph.D., *Professor Emeritus of Education*
Elizabeth Read Sunderland (1939-42; 1943), Ph.D., *Professor Emeritus of Art*
Edgar Tristram Thompson (1935), Ph.D., *Professor Emeritus of Sociology*
James Nardin Truesdale (1930), Ph.D., *Professor Emeritus of Greek*
Richard L. Tuthill (1953), Ed.D., *Professor Emeritus of Economic Geography*
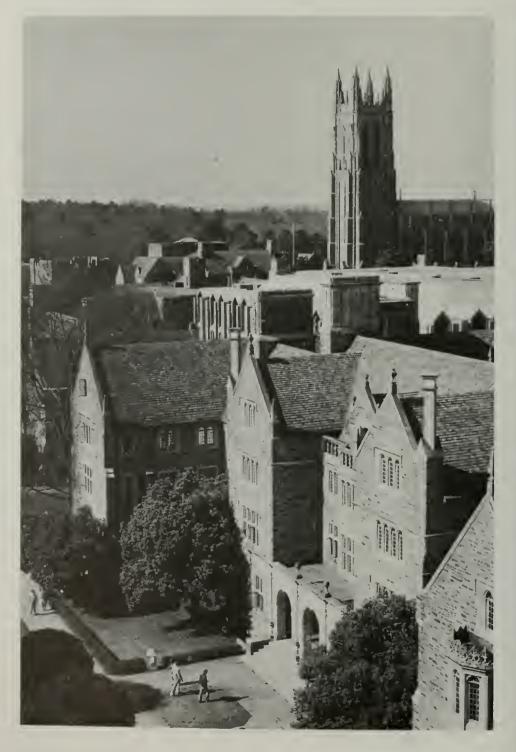Patrick R. Vincent (1954), Ph.D., *Associate Professor Emeritus of Romance Languages*
Warren Chase Vosburgh (1928), Ph.D., *Professor Emeritus of Chemistry*
Richard Lyness Watson, Jr. (1939), Ph.D., *Professor Emeritus of History*
Henry Weitz (1950), Ed.D., *Professor Emeritus of Education*
Bruce A. Wells (1964), M.S.E.E., *Associate Professor Emeritus of Electrical Engineering*
Paul Welsh (1948), Ph.D., *Professor Emeritus of Philosophy*

Karl Milton Wilbur (1946), Ph.D., *James B. Duke Professor Emeritus of Zoology*
William Hailey Willis (1963), Ph.D., *Professor Emeritus of Greek in Classical Studies*
Robert Hilliard Woody (1929), Ph.D., *Professor Emeritus of History*
Franklin W. Young (1944-50; 1968), *Amos Ragan Kearns Professor Emeritus of New Testament and Patristic Studies*

To the Prospective Graduate Student

A Graduate School is where excellence is established in a university. At Duke, the Graduate School is where the two essential functions of a university, teaching and research, truly come together. Over the years Duke's strength at the graduate level has grown in all the main fields of knowledge. The nineteen-eighties have been particularly fruitful years for recruitment of faculty, establishment of new programs, and attraction of outstanding students. The faculty enjoys international distinction. The laboratories, libraries, and computer facilities are among the very best. Yet the Graduate School remains small enough so that personal contact is a central feature of our programs, and fruitful interaction across disciplines is a common experience, both for faculty and students.

For the student in search of a strong graduate education, Duke University has much to offer. This is a community in which minds and ideas grow. We provide training for many careers, but we seek also to foster personal creativity and to provide stimulating yet congenial surroundings for productive education and research.

The following pages provide the information you require in making the important choice of the course of your graduate education. We look forward to welcoming you to the Duke community of scholars.

Malcolm Gillis
Dean of the Graduate School

Academic and Cooperative Programs

Admission

Degree and Nondegree Admission

All students seeking a graduate degree from Duke University must formally be admitted to the Graduate School. Prerequisites for such admission include a bachelor's degree (or the equivalent) from an accredited institution and satisfactory scores on the Graduate Record Examination. Individual departments may specify additional prerequisites, which can be found in the chapter on "Courses of Instruction."

Students who do not intend to earn an advanced degree at Duke, but who wish to take graduate courses, may apply for nondegree admission. Such admission is granted in three different categories (1) admission as a regular nondegree student with a particular department; (2) admission as a special nondegree student without departmental affiliation through the Office of Continuing Education; and (3) admission as an unclassified student in the summer session only.

Students who have discontinued a program of degree work at Duke must apply for readmission to the Graduate School. Those who discontinue study *prior* to completing a degree must, by letter, request permission of the Dean to be readmitted to the degree pr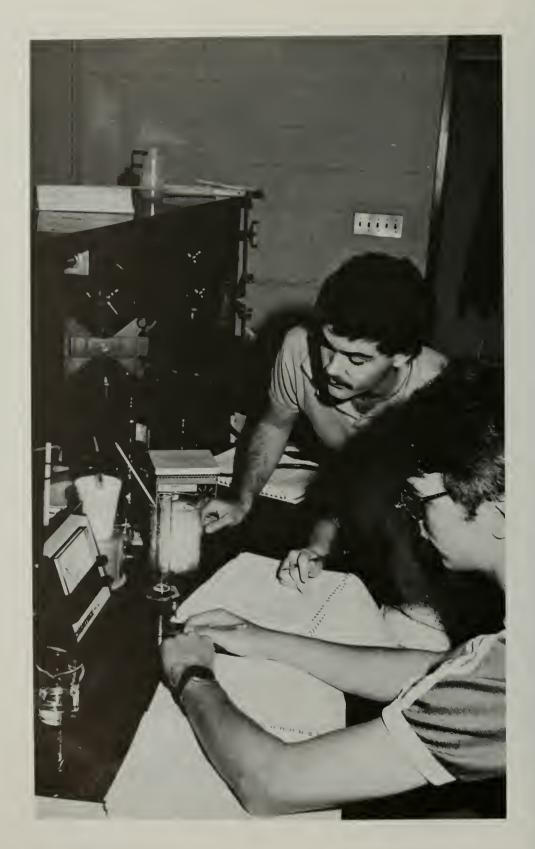ogram; those who discontinue study *after* earning a master's degree must file a new application for the doctoral program.

Credits earned by nondegree students in graduate courses taken at Duke before full admission to the Graduate School may be carried over into a graduate degree program if (1) the action is recommended by the student's Director of Graduate Studies and approved by the Dean, (2) the work is not more than two years old, (3) the amount of such credit does not exceed 12 units, and (4) the work has received grades of G or better.

Admission Procedures

A student seeking admission to the Graduate School should obtain an application packet from the Graduate School Admissions Office. This packet contains the necessary forms and detailed instructions on how to apply. The application form must be filled out completely, signed, and returned to the Graduate Admissions Office accompanied by a nonrefundable fee of $35* in U.S. currency (check or money order) payable to Duke University. In addition, the student should provide the following supporting documents: (1) two copies of the official transcript from each postsecondary institution attended, sent directly to the Graduate

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*All fees are based on current charges and are subject to change without notice.

School by the institution; (2) three letters of evaluation, written on the forms provided and returned by the applicant in the confidential envelopes that have been sealed-then-signed by the evaluators (or returned directly to the Graduate School by the evaluator); (3) official scores on the Graduate Record Examination General Test for applicants to all departments; and (4) official scores on the Graduate Record Examination Subject Test for applicants to programs in botany, English, literature, mathematics, music, physiology, and zoology. It is recommended that a student take the GRE Subject Test if applying to anatomy, biochemistry, chemistry, geology, microbiology and immunology, pathology, physics, political science, or Romance languages. Applications cannot be reviewed until all supporting documents are on file. *Materials submitted in support of an application are not released for other purposes and cannot be returned to the applicant.*

Students applying for financial aid in all departments should take the Graduate Record Examination no later than the October testing in the previous year in order to meet the January 31 deadline. (The deadline is January 15 for all programs in psychology.) Information on the times and places of the Graduate Record Examinations can be obtained from the applicant's college or the Educational Testing Service, CN 6000, Princeton, New Jersey 08541-6000.

Additional Procedures for Foreign Students. Fully qualified students from outside the United States are invited to apply for admission to full-time study in the Graduate School. The foreign student must, in addition to the information required of all students, submit with the application materials: (1) if the student's native language is not English, certification of English proficiency demonstrated by official scores from the Test of English as a Foreign Language (TOEFL), administered through the Educational Testing Service, CN 6155, Princeton, New Jersey, 08541-6155 (the Graduate School requires a minimum score of 550); and (2) a statement showing financial arrangements for the proposed term at Duke (estimated costs per calendar year are about $17,000).*

During the matriculant's first registration period at Duke, every foreign student whose native language is not English will be required to take a test to verify competence in the use of oral and written English. Until such competence is determined, admission and arrangements for an award involving teaching must remain provisional. Students found to lack necessary competence should be prepared to undertake additional English language instruction. Students who do not pass the competency test by the end of their first year of residency will not be permitted to continue graduate work at Duke University. Please note that the competency test does not take the place of the TOEFL 550 requirement.

Part-Time Graduate Study. Many graduate departments will consider applications from students wishing to pursue degree study on a full-time or part-time basis. Admission requirements, procedures, and deadlines are the same in either case. See the chapter on "Registration" for additional rules governing minimum registration, time limitations, and financial aid restrictions on part-time study. *Visa restrictions do not allow nonimmigrant students to pursue graduate study on a part-time basis.*

Master of Arts in Liberal Studies Procedures. Students seeking admission to the MALS should contact that program directly for information, requirements, and special application materials.

Summer Session Procedures. Students who wish to begin graduate work during the summer must, in addition to applying for regular admission to the Graduate School, apply for admission to the summer session. Application forms

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*Figures are based on 1986-87 charges and are subject to change before the fall 1987 semester.

may be obtained from Summer Session, 121 Allen Building, Duke University, Durham, North Carolina 27706, and may be submitted at the time of registration.

Students who wish to take graduate courses in the summer but not pursue a graduate degree may be admitted to the summer session under the following categories. *Duke Students:* current students in good standing may attend the summer session without formal application. *Non-Duke Students:* other persons may seek admission to the summer session provided they are (or were) in good standing at a fully accredited college or university.

Continuing Education Procedures. A student seeking admission as a nondegree continuing education graduate student at Duke must have received a bachelor's degree and must either reside in the area or be moving to the area with the intention of residing here for a substantial period of time. Application materials and additional information may be obtained from the Office of Continuing Education, The Bishop's House, Duke University, Durham, North Carolina 27708.

Review of Application and Notification of Status. All applications are considered without regard to race, color, religion, sex, age, handicap, or national origin. A departmental admissions committee, usually headed by the Director of Graduate Studies, reviews the application and makes a recommendation to the Dean. Formal admission to the Graduate School is offered only by the Dean who will

contact the student in writing. An admission offer is only for the semester specified in the letter of admission, and admission may not be deferred automatically from one term to another.

Deadlines for Application

It is the applicant's responsibility to make certain that the Graduate School office has received all required materials before the specified deadlines. Only complete applications can be considered. To ensure that the admissions office will have adequate time to assemble all items submitted on an applicant's behalf, applications should be sent at least *two weeks* before the stated deadlines.

FOR FALL SEMESTER

January 15. Final date for completion of applications to all programs in *psychology only.*

January 31. Final date for completion of applications for admission *and* award for the fall semester. This is the *priority filing date;* applications completed after this date may be considered for admission, if all spaces have not been filled, and for financial aid, if funds are still available. All students seeking fall admission should complete their applications by January 31, since it is likely that enrollment in many departments will be filled soon after this date. Applications that are incomplete cannot be considered for awards until decisions have been made on all complete applications.

July 15. Final date for completion of applications for admission *without award* for the fall semester, space permitting. *No applications for fall received after this date will be considered.*

FOR SPRING SEMESTER

November 1. Final date for completion of applications for admission to the spring semester, space permitting. Not all departments accept new students for the spring semester, nor is financial aid readily available for spring matriculants.
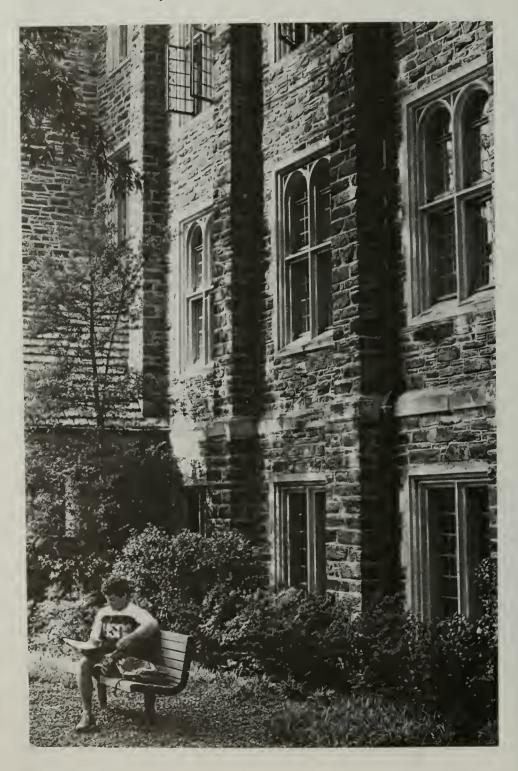
FOR SUMMER SESSION

Students seeking admission to the Graduate School for study in the summer session should apply to the Dean of the Graduate School and to the Director of the Summer Session.

April 15. Last day for completing application to summer session Term I.

May 15. Last day for completing application to summer session Term II.

Financial Information

Tuition and Fees*

NEW STUDENTS ENROLLING FALL SEMESTER 1987

The 1987-88 tuition for new students enrolling full-time during the fall semester (except those students in health administration and physical therapy) is $3,444 (12 units at $287 per unit) or $2,583 (9 units at $287 per unit) for teaching and research assistants. In addition to tuition a registration fee of $150 (not applicable for students who matriculated before fall semester 1985) is required each semester. Part-time tuition is calculated at the rate of $287 per unit in the fall and spring and at the rate of $266 per unit in the summer.

Payment of Accounts. Duke University does not have a deferred payment plan for tuition, fees, or other charges. New students are expected to pay tuition and fees at the time of matriculation. Following first enrollment in the Graduate School, monthly invoices are sent each student by the Bursar's office. As a part of the agreement of admission to Duke University a student is required to pay all invoices upon receipt.

Graduate students who receive payments from the University for fellowships, assistantships, or employment and who plan to pay tuition and fees and/or campus housing charges via payroll deduction must make arrangements for payroll deduction in the Bursar's office by the published deadline for each semester in order to avoid assessment of the late payment charge.

All full-time graduate students and part-time degree candidates are charged the student health fee as well as student accident and sickness insurance coverage unless they file properly completed and signed insurance waivers in the Bursar's office by the invoice date. Students registered *in absentia* are not charged the health fee and insurance unless they elect to enroll in the insurance plan. *The student accident and sickness insurance payment is due in full at the beginning of the term (insurance may not be paid by payroll deduction). Payment in full for campus housing is due at the beginning of each semester unless the student qualifies for University payroll deduction.*

Late Payment Charge. A late registration fee of $25 is charged any student who does not complete registration during the announced registration periods. Students who fail to pay by the due date the total amount of an invoice received from the Bursar will be charged a late payment fee. That fee is assessed at the rate of 1 1/3 percent per month (16 percent per year) applied to the past due

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*All fees are based on current charges and are subject to change without notice.

balance and accrued from the billing date of the invoice (matriculation date for new students).

Restrictions. A student in default on tuition or fee charges will not be allowed to register for classes, receive a transcript of academic records, have academic credits certified, be granted a leave of absence, or receive a diploma at graduation. In addition, such students may be subject to withdrawal from the Graduate School.

Reduction in Registration and Tuition. Full refunds are granted students who reduce registration on the drop/add date at the beginning of each semester. A reduction in registration and tuition necessitated by changes in departmental service requirements for assistants may be made during the first week of classes with approval of the Dean.

Refunds for Withdrawal from School during Fall and Spring Semesters. For students who withdraw from school or who are withdrawn by the University, refunds of tuition and fees are governed by the following policy.

1. In the event of death, refund of full tuition and fees will be granted.
2. In all other cases of withdrawal from the University, students or their parents may elect to have tuition refunded or carried forward as a credit for later study according to the following schedule:
   a. Withdrawal before classes begin: full refund;
   b. Withdrawal during the first or second week of classes: 80 percent refund (the student health fee will not be refunded);
   c. Withdrawal during the third, fourth, or fifth week of classes: 60 percent refund (the student health fee will not be refunded);
   d. Withdrawal during the sixth week: 20 percent refund (the student health fee will not be refunded);
   e. Withdrawal after the sixth week: no refund.
   f. Tuition charges paid from grants or loans will be restored to those funds on the same pro rata basis and will not be refunded or carried forward.
3. If a student has to drop a course for which no alternate registration is available, drops special fee courses (music, golf, etc.), or drops a paid audit during the first two weeks of the drop/add period, a full refund may be granted with the approval of the Dean. (The student health fee will not be refunded.)

Withdrawal Charges and Refunds during Summer Session. Students who will not be attending a summer term or course(s) for which they have registered must follow the correct procedure and drop the course(s) prior to the first day of the term, even if they have not paid tuition and fees. Failure to drop the course(s) will result in administrative withdrawal from the summer session at the end of the first three days of the term and in billing the student for 20 percent of the tuition plus the health fee. If tuition and fees have been paid for the summer term, the following refund policies apply:

1. When applications for withdrawal from a term or drop of a course are received by the Director of the Summer Session before the first class day of a given term, full tuition and fees will be refunded.
2. When applications for withdrawal are received by the Director during the first three class days, 80 percent of the tuition will be refunded. (The health fee will not be refunded.)
3. When applications for withdrawal from a term or drop of a course are received by the Director after the third class day, there will be no refund of tuition and fees.

Special Tuition Benefits for Employees. The Graduate School recognizes a special obligation to encourage the professional and personal advancement of employees. The University thus grants reductions in tuition to eligible employees enrolling in courses offered by the University.

Half-time employees with one or more years of continuous service who receive permission of their supervisors may take up to two courses a semester and will be charged one-half of the tuition rate. This benefit applies *only* to nondegree work. Full-time employees (30 or more hours a week) with two or more years of continuous service who receive permission to take such courses will be charged one-tenth the tuition rate for up to two courses per semester and will be permitted to audit at no charge. This benefit applies to degree work as well as nondegree.

Employees who wish to take graduate classes on a nondegree basis apply through Continuing Education. No Graduate Record Exam is required at this point. If an employee is later admitted into a degree program, up to 12 semester hours of these credits may then be transferred into that program.

Employees wishing to enroll directly into a graduate or professional degree program apply directly to those schools. Since not all of these programs can accommodate part-time study, please make early contact with the appropriate dean for advice on your particular educational needs.

Eligible employees should consult the Benefits Office, 705 Broad Street, (919) 684-6723, at least one week in advance of payment date to obtain the appropriate tuition voucher.

Thesis or Dissertation Fees. Fees incurred in connection with a thesis or dissertation are as follows:

Binding fee, three University copies of thesis or dissertation*	$22.50
Microfilming fee, doctoral degree only, upon final submission	$40
Copyright fee (doctoral degree only, optional)	$20

Athletic Fee. An athletic fee of $100 for football and basketball games, or $25 for football games only, is optional and payable in the fall semester. The Treasurer of the University has sole responsibility for collection of fees.

Fee for Undergraduate Courses. Graduate students registering for undergraduate courses will be assessed 3 units for a nonlaboratory course and 4 units for a laboratory course.

Marine Laboratory Fee. For Marine Laboratory investigators' research table fee, see the *Bulletin of Duke University: Marine Laboratory.*

Audit Fee. Students registered full time during fall and spring may audit courses without charge. Students may not audit activity courses, e.g., physical education, or applied music. Otherwise, audit fees are $125 per course.

During the summer, students registered for a full course program (two courses) may audit nonlaboratory courses (except physical education activity courses, applied music courses, and studio art courses) with the permission of the instructor and the Director of the Summer Session at no extra charge. Students carrying less than a full course program during the summer may be granted permission by the instructor and the Director to audit a course (above restrictions apply), but must pay half the University tuition charge for the course.

Vehicle Fee. Each student possessing or maintaining a motor vehicle at Duke University must register it at the beginning of the fall semester with the security office at 2010 Campus Drive. A student who acquires a motor vehicle and maintains it at Duke University after academic registration must register it within five calendar days after operation on the campus begins. Resident students are required

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*A deposit of $5 will be collected for each additional snap binder needed beyond the binders for University copies.

to pay an annual fee of $30 for each motor vehicle or $15 for each two-wheeled motor vehicle. Resident students registering a vehicle for the first time after January 1 are required to pay $20 for a motor vehicle or $10 for a two-wheeled motor vehicle.

If a motor vehicle or a two-wheeled vehicle is removed from the campus permanently and the decal is returned to the traffic office prior to January 20, there will be a refund of $10 for a motor vehicle and $5 for a two-wheeled motor vehicle.

Students enrolled in the summer session only must also register their motor vehicles with the traffic control office. The fee is $4.50 for thirty days.

Transcript Fee. Students who wish to obtain copies of their academic records should direct requests to the Registrar's office. A fee of $1 is charged for each copy.

The Student Health Fee. All full-time students and part-time degree candidates (except those registered *in absentia*) are assessed a fee for the Student Health Service. For the fall and spring, the fee is $214 ($107 each semester). For the summer, the fee is $35 per term. The health fee will be $29 for each five-week period at the Marine Laboratory.

Expenses*

Housing Fee. The fee for Town House Apartments, not including utilities, is $1,953 per occupant for the fall and spring on the basis of two students to a two-bedroom apartment. The fee for modular homes, not including utilities, is $1,717 per occupant on the basis of three students to a home. Rates in Central Campus Apartments range from $1,961 for three students in a three-bedroom apartment to $3,028 for an efficiency apartment.

Apartments are available during the summer and rates vary according to the type of unit desired and the number of persons occupying the apartment.

Housing fees are subject to change prior to the 1987-88 academic year. A $100 deposit is required with all applications. Refund on housing fees is made in accordance with the schedules published by the Department of Housing Management. For further information on housing facilities, see the section on living accommodations in the chapter on "Student Life."

Food. Food service is described in the section on living accommodations in the chapter on "Student Life." The cost of meals is estimated at a minimum of $9 per day, or about $2,085 for the academic year.

Summary. The table below represents an estimate of a graduate student's basic expenses during the fall and spring for a full program of work. Miscellaneous items (recreation, travel, clothing, laundry, etc.) will vary according to personal needs and tastes.

Tuition	$6,888 (24 units)
Registration fee	300
Student health fee	214
Apartment rent	
(Central Campus Apts.)	2,308
Meals	2,231
Books	535
Miscellaneous (laundry, etc.)	2,204
Total	$14,680

The estimated cost for one term of the summer session is:

*The figures contained in this section are based on 1986 figures and are subject to change prior to the beginning of the fall 1987 semester.

Tuition (two nonlaboratory courses or 6 graduate units)	$1,596
Registration Fee	100
Student health fee	35
Apartment Rent (Central Campus Apts.)	392
Meals	500
Books and class materials (average)	60
Miscellaneous (laundry, etc.)	203
Total	$2,886

Fellowships and Scholarships

Application Procedure. Fellowships and scholarships are available to students in most graduate programs. A student who wishes to be considered for any of the following fellowships, scholarships, or assistantships should so indicate on the application form for admission and award. Selection of award recipients is made on the basis of academic merit and departmental recommendations.

While personal financial need may not be the basis for the granting of many graduate awards, the Graduate School requires all matriculating students (except non-United States citizens) to complete the Graduate and Professional Student Financial Aid Service (GAPSFAS) form.

James B. Duke Fellowships. The James B. Duke One-Hundredth Anniversary Fund provides fellowships for students who wish to pursue a program leading to the Ph.D. degree in the Graduate School at Duke University. Its objective is to aid in attracting and developing outstanding scholars at Duke. Selection of recipients is made by a faculty committee upon nomination by the appropriate department. These fellowships provide for payment of tuition for full registration during the academic year, plus the registration fee during the summer sessions. They also provide an income stipend of $1,000 per month for twelve months during the duration of the award. Students entering with baccalaureate degrees may hold this fellowship for three years. Students entering with master's degrees may be fellows for two years. The award requires no service and is renewable each year if the student is satisfactorily progressing toward the degree. The total value of a James B. Duke Fellowship over the three years of tenure for a student who enters Duke with the B.A. degree is over $60,000 at current tuition rates. There are fifty James B. Duke fellows currently enrolled.

Andrew W. Mellon Graduate Fellowships in the Humanities. As many as six one-year dissertation fellowships are awarded to graduate students in the humanities. Selection of recipients is made by a faculty committee upon recommendation by the appropriate department. These fellowships provide for payment of tuition and health fees plus a monthly stipend.

Endowed Fellowships. Other special endowments provide fellowships for graduate study. The Angier B. Duke Fellowship provides support on the same level as the James B. Duke Fellowship for one student for the academic year. There are five Gurney Harris Kearns Fellowships in religion. Selection for these fellowships is made through faculty committees. The E. Bayard Halsted Fellowship in science, history, or journalism is awarded to a graduate of Duke University intending to pursue an advanced degree at Duke. The Frank T. de Vyver Fellowship, administered by the Department of Economics, is awarded each year to an outstanding student entering the doctoral program in economics. The Clare Hamilton Memorial Endowed Fellowship is awarded yearly on the basis of merit and need to one or more outstanding students in clinical psychology. The Charles R. Hauser Fellowship is awarded to an outstanding graduate student in the last year

of work toward a Ph.D. degree in organic chemistry. The Calvin Bryce Hoover Fellowship is administered by the Department of Economics and is awarded each year to an outstanding student entering the doctoral program in economics. The Robert R. Wilson Fellowship in the Department of Political Science is awarded to a student currently enrolled in or entering a doctoral program in international law, international organization, or international relations. The Gertrude Weil Fellowship, administered by the Department of Religion, is awarded to students interested in Judaic studies. The John L. Lievsay Fellowship is awarded to a dissertation-year student in English literature. The Anne McDougall Memorial Award for Women, administered through women's studies, is awarded each year to one woman student studying psychology or a related field.

Graduate Fellowships. Graduate fellowships funded by Duke University are available to students in the Graduate School for study during the academic year. Awards, which include tuition, range from $8,610 to $15,000. In 1986-87, 275 students held these fellowships.

Federal Fellowships. * Duke University participates in the following programs:

National Science Foundation Fellowships. A number of students hold National Science Foundation Graduate Fellowships which provide tuition plus a stipend of $11,100.

National Graduate Fellows Program. Three students received the National Graduate Fellowships in 1986-87. This federal program for students in the humanities provides tuition plus a stipend of up to $10,000 based on the student's need.

Other federal programs support fellowships, traineeships, and research assistantships through departmental auspices. Approximately 300 students were supported through these programs during 1985-86.

Fellowships in Medieval and Renaissance Studies. Three fellowships are awarded annually by the Duke University Committee on Medieval and Renaissance Studies. Fellows are chosen from among students enrolled in Ph.D. programs. They receive full tuition, plus a monthly stipend of $800 for nine months, and may request two renewals of the appointment.

Special Fellowships. The following special fellowships are available to qualifed Duke students from sources outside the University:

Shell Fellowships. Available to students in the social sciences engaged in dissertation research on developing countries. Recipients must be citizens of the United States or permanent residents intending to become United States citizens. The fellowships are designed to cover the expenses of field research in the preparation of doctoral dissertations. The stipend for each fellowship is $7,000 plus a reasonable amount for transportation expenses. Recipients are chosen competitively from departmental nominees. Inquiries should be made to the Program Coordinator, Center for International Studies, 2122 Campus Drive, Durham, North Carolina 27706.

Exchange Fellowships with the Free University of Berlin. Fellowships are available through an exchange arrangement with the Free University of Berlin which will provide funds for one graduate student to study during the regular academic year in Berlin. Interested students should write to the Dean of the Graduate School prior to February 1.

Graduate Fellowships for Minority Students. A substantial pool of fellowship funds is reserved for the support of minority students, in some instances with a multi-year commitment. The funds are allocated with advice from a special committee of the Graduate faculty.

James B. Duke International Studies Fellowships. Available to outstanding stu-

*United States citizenship is generally a requirement for eligibility.

dents from foreign countries who have completed their undergraduate education in institutions outside the United States. Eligibility criteria include concentration in areas broadly defined as international studies, and admission to a Ph.D. program in Duke's Graduate School. Fellowships provide an annual stipend of $12,000, payable for twelve months, plus tuition and health fees. They are renewable for three years. Recipients are chosen competitively from departmental nominees by a faculty committee. In addition, the program offers a one-year fellowship to an advanced Duke graduate student planning dissertation research abroad in the field of international studies who has passed the preliminary examinations by the time the award begins.

Departmental Fellowships. Various departments and schools within Duke University have fellowships which are available to students pursuing graduate study. Information may be obtained from the individual departments.

Graduate Scholarships. Graduate scholarships funded by Duke University are available to students in many departments of the Graduate School for study during the academic year. Awards are for full or partial payment of tuition; they range in value to $8,610. In 1985-86, approximately 150 students held graduate scholarships.

Assistantships

Graduate Assistantships. Appointments as graduate assistants carry a total stipend of up to $8,070 for the academic year. The value of the stipend is determined by the time spent in assisting, the qualifications of the assistant, and the nature of the work assigned. Graduate assistants also may receive tuition scholarships in addition to payments for service as an assistant. In 1986-87, approximately 200 students held graduate assistantships.

Research Assistantships. Appointments are available for graduate students whose special training and qualifications enable them to serve as assistants to individual staff members in certain departments. Stipends may be up to $8,400, depending on the nature of the assistance and the assisting time required. In 1986-87, approximately 186 students held research assistantships.

Part-time Instruction. Several departments offering graduate work have exceptionally qualified graduate students work as part-time instructors, tutors, and teaching assistants. Amounts of these assistantships vary and interested applicants should contact their departments directly.

Payment of Awards

The payment of stipends for graduate assistantships and fellowships starts on September 25 and is made in equal payments on the twenty-fifth day of each month thereafter. Under the Tax Reform Act of 1986, the only graduate student financial assistance exempt from taxation are amounts paid for tuition, fees, books, supplies, and equipment required for course instruction. If services are required for payment of tuition and fees, then that tuition is considered income and is subject to taxation. The graduate school office will supply detailed information.

It is the responsibility of the student to be sure that tuition and fees are paid or that arrangements have been made with the appropriate office or department for submission of tuition payment notices to the Bursar (101 Allen Building). Graduate students should contact either the Director of Graduate Studies in their department or the Graduate School Financial Aid Coordinator (123 Allen Building) depending upon the type of award. Faculty, senior administrative staff, employees, and eligible spouses not in degree programs should contact Harrison Brooke (303 Allen Building) regarding tuition benefits.

Loans

Students who anticipate a need to supplement their financial resources through loans or college work-study employment must obtain and complete a Graduate and Professional Student Financial Aid Service (GAPSFAS) form. These forms are available at most financial aid offices or from the Financial Aid Coordinator, Graduate School, Duke University, Durham, North Carolina 27706. A student seeking a loan should contact his or her state lending agency.

It is the policy of the Graduate School to provide loans through the University to help students meet their educational expenses. Only students with full-time status who meet the federal criteria for need are eligible for loans. Loan funds are provided through the National Direct Student Loan Program after a student has borrowed the maximum from the Guaranteed Student Loan Program. Generally, loans made from these funds, as is the case with loans from state agencies, bear no interest charge to qualified borrowers while they maintain student status and for a short period thereafter. Interest during the repayment period is at a favorable rate.

Inquiries concerning loans should indicate the department of intended matriculation and include all pertinent information concerning application to a state agency. These inquiries should be addressed to the Financial Aid Coordinator, Graduate School, Duke University, Durham, North Carolina 27706.
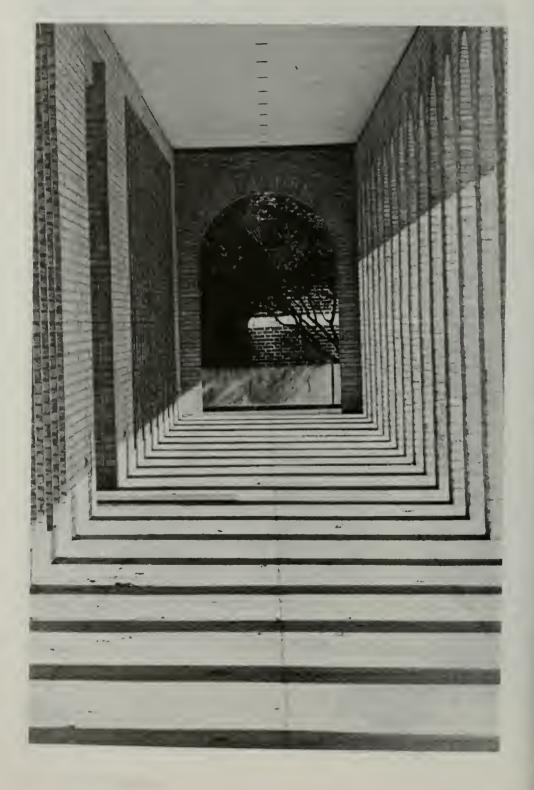
Work-Study Program Employment

Funds are available through the college work-study program for short-term or part-time employment of graduate students. A student who wishes to apply for work-study must complete a GAPSFAS form. Students considering the possibility of work-study for the fall should submit GAPSFAS forms by April 15. Eligibility requirements are similar to those of the federal loan programs. In addition to departmental employment opportunities, the placement office maintains a listing of employment openings for students.

Summer Financial Aid

A limited amount of financial aid is available to students in summer study. Summer financial aid, determined according to demonstrated need, may consist of institutional grant funds and/or low interest loans from the Federally Insured Student Loan program and the National Direct Student Loan program. To qualify for summer school aid, a student must be enrolled or accepted for enrollment at Duke during the academic year immediately preceding the summer for which aid is requested. (Students enrolled only for the summer may be eligible to borrow from outside lenders under the Federally Insured/Guaranteed Loan program in their home states or from the schools at which they are regularly enrolled. They should contact their college's financial aid office or the state's department of higher education for information and applications.) The college work-study aid is determined by the financial aid office based upon the student's financial need and the availability of funds. Graduate awards are determined by departments depending on usual criteria and availability of funds.

Registration

Registration for Fall 1987

All new students must register each fall and spring semester for credit toward their degrees and pay a registration fee each semester unless waived by an approved leave of absence granted by the Dean. Doctoral students are expected to register for 60 units of credit. After the 60 units of credit have been achieved, the student will pay only the registration fee each semester until all degree requirements have been met. A master's student (except for those students enrolled in the two-year health administration, physical therapy, and public policy studies programs) will register for a minimum of 30 units of degree credit and for any course units beyond the 30 required of their program. A registration fee is charged each semester.

Approved transfer course work into a master's program will *not* reduce the minimum registration for a master's degree of 30 units at Duke University. Approved transfer of an earned master's degree will reduce the minimum doctoral registration to 45 units of degree credit at Duke University.

Full-time students will register at the rate of either 9 units as teaching or research assistants or 12 units each semester until the minimum units of degree credit have been completed. Part-time students will register for a minimum of 3 units per semester.

Students who are in residence during the summer session, but not enrolled in any courses, pay only the registration fee.

Except for these registration procedures, all other degree regulations remain as stated in the other sections of this bulletin.

All students who enrolled prior to 1985 should consult the bulletin of their year of matriculation for registration procedures and requirements.

Registration Periods. All students who are enrolled in the Graduate School and who have not been granted a leave of absence by the Dean must register each fall and spring until all degree requirements are completed. New students will register immediately prior to the first day of classes in either term; continuing students register during the announced preregistration periods in November and March. Students who have been on leaves of absence and who intend to resume a degree program must give the department and the Dean notice of this intention two months before registration.

Late Registration. All students are expected to register at the times specified by the University. A late registration fee of $25 is charged any student registering late, including a current student who delays registering until the special registration for new students.

Change of Registration. During the first two weeks of the fall or spring semester,

registration may be changed with the approval of the Director of Graduate Studies if no reduction of fee is entailed. If fees are to be refunded, the approval of the Dean of the Graduate School is required. For the succeeding two weeks, courses may be dropped and equivalent hours of ungraded research or residence added with the approval of the Director of Graduate Studies and the Dean.

Summer Registration. Students who are in residence at Duke University during the spring and who plan to enroll for courses in the summer session may have their course programs approved by the Director of Graduate Studies during the week of Graduate School registration in March. Course cards for courses or graded research should be submitted to the Office of the Summer Session. Summer session students may register in the summer session office at any time beginning with the March registration period and up to the Wednesday preceding the start of the appropriate term. Graduate students who intend to remain in residence during one or more of the summer session terms without registering for course work must either register for 1 unit of research (students who matriculated prior to fall 1985) or pay a summer registration fee (students who matriculated fall 1985 or later).

Students who are not in residence at Duke during the spring (including newly admitted students to the Graduate School and students of other colleges and universities desiring to earn credits for transfer) may register by mail for the summer session. Advance registration by mail includes:

1. Completion of the summer session application. (Applications may be obtained by writing to the Office of the Summer Session, 121 Allen Building.)
2. Admission to the summer session by the Director of the Summer Session. (Students who have been admitted to the Graduate School for the summer term need not apply to the summer session.)
3. Submission of a properly approved and completed course card in the Office of the Summer Session.

The University does not mail statements for summer session tuition and fees. All tuition and fees should be paid in the Office of the Bursar (101 Allen Building) at least *five full working days* prior to the first day of class (see summer session calendar). Students who fail to register and pay all tuition and fees before this deadline will be assessed a late charge. Failure to pay tuition and fees by the end of the drop/add period will result in administrative withdrawal of the student.

After April 30 all course changes must be approved by the appropriate director of graduate studies. The Director of the Summer Session serves as the dean for all non-Duke students. Course changes are accomplished by submitting the three-part drop/add form to the Office of the Summer Session, 121 Allen Building. Students who are out of town must contact their director of graduate studies directly to arrange for dropping or adding courses.

Summer session students may add a course or courses before or during the first three days of the term. Courses may also be dropped before and during the first three days, but a 20 percent tuition fee will be charged (1) if the course is not dropped before the first day, and (2) the dropped course(s) results in a total tuition reduction. Courses dropped after the third day of classes are not eligible for tuition refund.

Additional Registration Requirements. It is necessary to be a fully registered student according to the regulations listed in the chapter on "Registration" in order to be eligible for library carrel and laboratory space, student housing, University and some outside loans, and the Student Health Service, including accident and sickness insurance. See the chapter on "Student Life."

Part-time graduate students must be enrolled for at least 8 units each semester in order to qualify for loans (National Direct Student Loan, Guaranteed Student Loan).
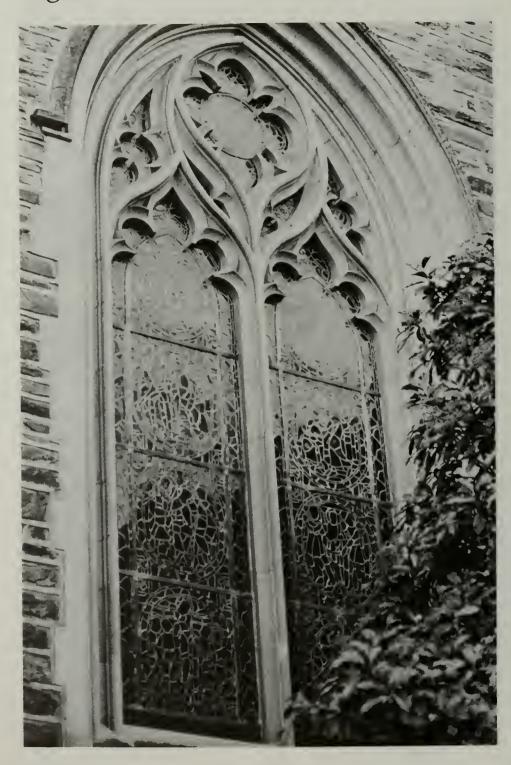
Regulations

General Academic Regulations

Credits. The following regulations pertain to credits earned outside the Duke University Graduate School:

Graduate Credit Earned before the A.B. Degree Is Granted. Ordinarily no credit will be allowed for graduate courses taken before a student has been awarded the A.B. or B.S. degree. However, an undergraduate student at Duke University, who at the beginning of the final semester lacks no more than three courses in order to fulfill the requirements of the bachelor's degree, may apply for admission to the Graduate School for that final semester. If the student meets the requirements for admission, permission may be obtained from the Dean of the Graduate School to enroll for graduate courses to bring the total program to no more than five courses. In addition to undergraduate registration, the student must register in the Graduate School at the beginning of the semester in which graduate credit is to be earned in order for the courses to be credited toward a graduate degree program.

Transfer of Graduate Credits. Transfer of credit for graduate work completed at another institution will be considered only after a student has earned a minimum of 12 units of graduate study at Duke University. After completing the 12 units, the student should file a request for transfer of credits on the appropriate Graduate School form.

Summer Session Credit. Summer session *credit* does not mean degree credit at Duke University unless the student has been admitted as a degree candidate by one of the colleges or schools of the University. The majority of summer session courses carry 3 units of credit and require one term of residence. A student taking a course for credit is expected to do all the work required and to take the final examination, and will receive a grade. (*G. I. Bill benefits are available only to those veterans who enroll for credit.*)

Grades. Grades in the Graduate School are as follows: *E, G, S, F,* and *I. E* (excellent) is the highest mark; *G* (good) and *S* (satisfactory) are the remaining passing marks; *F* (failing) is an unsatisfactory grade; and I (incomplete) indicates that some portion of the student's work is lacking, *for an acceptable reason*, at the time the grades are reported. For students enrolled in the Graduate School, the instructor who gives an *I* for a course specifies the date by which the student must make up the deficiency. For unclassified graduate students enrolled in the summer session, a temporary *I* for a course may be assigned after the student has submitted a written request. If the request is approved by the instructor of the course, then the student must satisfactorily complete the work prior to the last day of classes of the subsequent summer term. If a course is not completed within

one calendar year from the date the course ended, the grade of *I* becomes permanent and may not be removed from the student's record. The grade of *Z* indicates satisfactory progress at the end of the first semester of a two-semester course. A grade of *F* in a major course normally occasions withdrawal from a degree program not later than the end of the ensuing semester or term; a grade of *F* in any other course occasions academic probation.

Reciprocal or Interinstitutional Agreements with Neighboring Universities. Under a plan of cooperation between Duke University and the University of North Carolina at Chapel Hill, North Carolina Central University in Durham, and North Carolina State University at Raleigh, students properly enrolled in the Graduate School of Duke University during the regular academic year, and paying full fees to this institution, may be admitted to a maximum of two courses per semester at one of the other institutions in the cooperative plan. A Ph.D. student who matriculated prior to fall semester 1985, who has passed the preliminary examination, and who registers for a minimum of 3 units at Duke, may register for 3 to 6 additional units at the other institution. Under the same arrangement, students in the graduate schools in the neighboring institutions may be admitted to course work at Duke University. Credit so earned is not defined as transfer credit. To take advantage of this arrangement during any summer session term, the student registers each term for 3 units of credit at the home institution and 3 units of credit at the other institution, for a total of 6 units. All interinstitutional registrations involving extra-fee courses or special fees required of all students will be made at the expense of the student and will not be considered a part of the Duke University tuition coverage. This reciprocal agreement does not apply to contract programs such as the American Dance Festival.

Identification Cards. Graduate students are issued identification cards which they should carry at all times. The card is a means of identification for library privileges, athletic events, and other University functions or services open to them as University students. Students will be expected to present their cards on request to any University official or employee. The card is not transferable, and fraudulent use may result in loss of student privileges or suspension from the Graduate School. A report of the loss of a card must be given immediately to the Registrar's office. The cost of a new ID card is $5.

Courses Primarily for Undergraduates. Students granted provisional admission and others whose preparation is found deficient may occasionally be required, as part of their programs, to take undergraduate courses as prerequisites to continued graduate study. Undergraduate courses thus taken and others elected by the student carry no credit toward a degree.

In exceptional cases, 100-level courses outside the major department may be taken for degree credit to a maximum of two one-semester courses or a one year course not exceeding a total of 8 units, when approved by the Director of Graduate Studies in the major department and in the department in which the course is listed. In order to receive credit for any such undergraduate work, the graduate student must earn a grade of at least *B*.

Withdrawal from a Course. For permissible changes during the first four weeks of the fall or spring semester and during the first two weeks of a summer session term, see the chapter on "Registration." If a course is dropped without the necessary approval, the permanent record will, at the discretion of the Dean of the Graduate School and with the permission of the instructor, list the course as withdrawal error (WE). If a course is dropped after the four-week period during the fall or spring or after the first three days of classes during the summer, the status of the student at the time of withdrawal from the course will be determined and indicated on the permanent record as *Withdrew Passing (WP)* or *Withdrew Failing (WF)*.

Interruption of Program and Withdrawal from the Graduate School. Students are expected to meet academic requirements and financial obligations, as specified elsewhere in this bulletin, in order to remain in good standing. Certain nonacademic rules and regulations must be observed also. Failure to meet these requirements may result in dismissal by the appropriate officer of the University.

The University reserves the right, and matriculation by the student is a concession to this right, to request the withdrawal of any student whose academic performance at any time is not satisfactory to the University. A student who wishes for any reason to withdraw from the Graduate School during the fall or spring should notify in writing both the Director of Graduate Studies in the major department and the Dean of the Graduate School prior to the date of the expected withdrawal. If students wish to withdraw from the summer session, they must consult both the Dean of the school or college in which they are registered and the Director of the Summer Session. For refunds upon withdrawal, see the chapter on "Financial Information."

A student who, after successfully completing one semester of graduate study, must withdraw before completion of a graduate program may, with the approval of the major department, request the Dean to issue a certificate of graduate study.

Leave of Absence. A leave of absence for a period of time no longer than one calendar year may be granted because of medical necessity, full-time employment, acceptance of an external award judged likely to benefit the student as an individual but not related to the degree requirements, or other acceptable reasons. A request for a leave of absence should be originated by the student, endorsed by the student's major professor and Director of Graduate Studies, and submitted to the Dean of the Graduate School for consideration prior to the beginning of the semester for which the leave is requested. A student is eligible to request a leave of absence only after having completed at least one semester at Duke. Time limitations which pertain to the various degrees and the completion of courses on which a grade of *I* (incomplete) was earned are not waived.

Language Requirements. The Graduate School has no foreign language requirement for any of the degrees. Individual departments, however, may require foreign language proficiency. See individual departmental sections in this bulletin or contact the appropriate Director of Graduate Studies to determine specific requirements.

Special Language Courses. Special courses designed to assist graduate students in acquiring a reading knowledge of French or German are offered for three hours a week during the fall and spring. Special language reading courses and language courses numbered below 200 carry no credit toward a degree. Undergraduates may not enroll in these special courses during the academic year but may register in the summer with permission of the Dean of the Graduate School, provided space is available after graduate students have been enrolled.

Degree Regulations — The Master's Degrees

MASTER OF ARTS

Prerequisites. As a prerequisite to graduate study in the major subjects, a student must have completed a minimum of 24 undergraduate semester hours — ordinarily 12 semester hours of approved college courses in the major subject and 12 semester hours in the major or in related work. Since some departments require more than 12 semester hours in the proposed field of study, students should read carefully the special requirements listed by their major departments in the chapter on "Courses of Instruction." If special master's requirements are not specified in this chapter and there is a question about the prerequisite, pro-

spective students should write directly to the appropriate Director of Graduate Studies.

Language Requirements. The Graduate School requires no foreign language for the master's degree. Certain departments, however, do have language requirements and these must be satisfied before the master's examination can be taken. See the departmental listings in the chapter on "Courses of Instruction."

Major and Related Subjects. Thirty units of graduate credit at Duke constitutes minimum enrollment for the Master of Arts degree. The students must present acceptable grades for a minimum of 24 units of course work, 12 of which must be in the major subject. A minimum of 6 units of the required 24 must be in a minor subject or in related fields which are approved by the student's major department. The remaining 6 units of the required 24 may be taken either in the major or in related fields approved by the major department and the Dean of the Graduate School.

Individual departments decide whether the M.A. program may be completed by submission of an approved thesis or by other academic exercises (see requirements listed in the chapter on "Courses of Instruction"). In either case, a maximum of 6 units may be earned by the completion exercises and the final examination.

Thesis Requirements. The thesis should demonstrate the student's ability to collect, arrange, interpret, and report pertinent material on a research problem. The thesis must be written in an acceptable style and should exhibit the student's competence in scholarly procedures. Requirements of form are set forth in the *Duke University Guide for the Preparation of Theses and Dissertations*, copies of which are available in the Graduate School office.

Four typewritten copies of the thesis bound in snap binders, which may be secured through the Graduate School office, must be submitted in an approved form to the Dean of the Graduate School on or before April 15 for a May degree, one week before the final day of the Duke University second summer term for a September degree, one week before the final day of the fall semester for a December degree, and at least one week before the scheduled date of the final examination. The copies then will be distributed by the student to the several members of the examining committee. Two copies for the library and one copy for the adviser will be bound upon payment of the University binding fee of $22.50.

The Examining Committee and the Examination. The faculty member who directs the student's program recommends an examining committee composed of three members of the graduate faculty, one of whom usually must be from a department other than the major department. If the student has been permitted to take related work within the major department, the third member may be chosen from within the department. Nominations for membership on this committee are submitted for approval to the Dean of the Graduate School at least one week preceding the final examination.

The committee will conduct the examination and certify the student's success or failure by signing the card provided by the Graduate School office. This card indicates completion of all requirements for the degree. If a thesis is presented, the committee members also sign all copies of the thesis, and the candidate then returns the original and first two copies to the Graduate School office.

MASTER OF SCIENCE

Prerequisites. A bachelor's degree is a prerequisite for the M.S. degree. Departments offering an M.S. degree consider for admission students from allied fields provided they have satisfactory scientific and mathematical backgrounds.

Language Requirements. There is no foreign language requirement in Master of Science degree programs.

Major and Related Subjects. Thirty units of graduate credit at Duke constitutes minimum enrollment for the Master of Science degree. The student must present acceptable grades for a minimum of 24 units of graduate courses. Of these, at least 12 units must be in the major subject. A minimum of 6 units must be in a minor subject or in related fields which are approved by the student's major department. The remaining 6 units of the required 24 may be taken either in the major or in related fields approved by the major department and by the Dean of the Graduate School. A maximum of 6 units may be earned either by submission of an approved thesis, or by completing courses or other academic activities approved by the student's department. As other requirements vary according to department, please consult the chapter on "Courses of Instruction" for further information.

Thesis and Examination. Some departments require a thesis; all departments require an examination. The regulations and options for theses and other means of completing the program, as well as the provisions for examination and the examining committee, are the same as the requirements for the Master of Arts degree.

MASTER OF HEALTH ADMINISTRATION

Prerequisites. Students with any undergraduate major may apply. Algebra at the college level is the only prerequisite, and a special course is available each summer for students whose preparation in mathematics is inadequate or out of date.

Major Subjects. The Master of Health Administration requires a minimum of 60 units of graduate credit, and the program is normally completed in four semesters.

Additional Master's Regulations

Filing the Intention to Receive Degree. On or before *February 1* for a May degree, on or before *August 1* for a September degree, or on or before *December 1* for a December degree, and at least one month prior to the final examination, the student must file in the Office of the Graduate School, on the official form, a declaration of intention to graduate. The declaration of intention presents the title of the thesis or specifies alternative academic exercises on which the degree candidate will be examined. During their final semester students may not change from a thesis program to a non-thesis program or from a non-thesis program to a thesis program after this form has been filed with the Graduate School Office. The declaration must have the approval of both the Director of Graduate Studies in the major department and the chairman of the student's advisory committee.

Transfer of Credits. A maximum of 6 accredited units of graduate credit may be transferred for graduate courses completed at other institutions. Such units will be transferred only if the student has received a grade of *B* (or its equivalent) or better. The transfer of graduate credit does not reduce the required minimum registration of 30 units for a master's degree at Duke. Requests for transfer should be submitted on the approved Graduate School form.

A student who is granted such transfer credit may be permitted to register for as much as 12 units of thesis research instead of the usual 6 units. As another option, a student may take as many as 6 units of further undergraduate training or 6 units of required language courses on the undergraduate level.

Nondegree Students. Credit for graduate courses taken at Duke by a student (not undergraduate) before degree admission to the Graduate School or while registered as a nondegree student through the Office of Continuing Education or the Graduate School may be carried over into a graduate degree program if (1) the action is recommended by the student's Director of Graduate Studies and approved by the Dean, (2) the amount of such credit does not exceed 12 units, (3) the work has received grades of G or better, and (4) the work is not more than two years old, and (5) the student applies for and is granted formal admission into a degree program.

Time Limits for Completion of Master's Degrees. Master's degree candidates who are in residence for consecutive academic years should complete all requirements for the degree *within two calendar years* from the date of their first registration in the Graduate School. Candidates must complete all requirements *within six calendar years of their first registration.*

To be awarded a degree in May, the recording of transfer credit must be completed by the first day of the final examination period and all other requirements must be completed by the last day of the final examination period. If a thesis is one of the requirements, it must be submitted to the Graduate School office no later than April 15. Candidates desiring to have their degrees conferred on September 1 must have completed all requirements, including the recording of transfer of credit, by the final day of the Duke University summer session. Candidates completing degree requirements after that date and during the fall will have their degrees conferred on December 30.

Degree Regulations—The Doctoral Degree

Requirements. The formal requirements for the Ph.D. degree are as follows: (1) major and related courses, (2) foreign language(s) in many departments, (3) a supervisory committee for the student's program of study, (4) residence, (5) preliminary examination, (6) dissertation, and (7) final examination. In order to be considered for candidacy for the Ph.D. degree, the student must have passing grades in all course work.

Major and Related Work. The student's program of study demands substantial concentration on courses in the major department. However, a minimum of 6 units in a related field approved by the major department must be included. A few programs have been authorized by the Executive Committee of the Graduate Faculty to utilize courses in fields within the major department in fulfilling the related field requirement. If there are deficiencies in a student's undergraduate program, departments may require certain undergraduate courses to be taken for which the student will not receive degree credit. In all cases the student's supervisory committee will determine if the student must meet requirements above the minimum.

Foreign Languages. The Graduate School has no foreign language requirement for the Ph.D. Some departments require two languages; other departments have no foreign language requirements. For specific departmental requirements, see the chapter on "Courses of Instruction" or contact the appropriate Director of Graduate Studies.

Students working toward the doctoral degree in a department requiring a foreign language(s) should complete this requirement by the end of their first year of residence. Those who fail to meet the requirement by the end of their third semester of residence should register in the appropriate special reading course. Any foreign language requirement must be met before the preliminary examination is taken.

Committee to Supervise the Program of Study. As early in a student's course of study as is practicable and *not later than two months before the preliminary examination,* the Director of Graduate Studies in the major department will nom-

inate for the approval of the Dean a supervising committee consisting of five members, with one member designated as chairman. This committee will include at least three graduate faculty members of the major department and, usually, at least one from outside the department. For programs in which approval has been granted for related work from a clearly differentiated division within the department, one member of the committee will be chosen from that division. This committee, with all members participating, will determine a program of study and administer the preliminary examination.

Residence. The *minimum* residence requirement is one academic year (two consecutive semesters in the same academic year) of full-time registration at Duke (that is, registration of 12 units each semester or, in the case of graduate assistants, 9 units each semester). The *minimum* registration requirement is 60 units of graduate credit, of which not more than 15 units of a completed master's degree may be accepted by transfer. Such transfer of credit will not reduce the minimum requirement of one full-time academic year at Duke.

Time Limits. Ordinarily a student registered for full-time study should pass the preliminary examination by the end of the third year. A student who has not passed the examination by the end of this time must file with the Dean of the Graduate School a statement, approved by the Director of Graduate Studies in the major department, explaining the delay and setting a date for the examination. Except under unusual circumstances, extension will not be granted beyond the middle of the fourth year.

The doctoral dissertation should be submitted and accepted within two calendar years after the preliminary examination is passed. Should the dissertation not be submitted and accepted within four years after the examination, the candidate, with the approval of the committee, may petition the Dean of the Graduate School for an extension of up to one year. If this extension is granted and the dissertation is not submitted and accepted by the new deadline, the student will be dropped from candidacy. The student must then pass a second preliminary examination to be reinstated as a candidate for the degree. In such cases, the time limit for submitting the dissertation will be determined by the Dean of the Graduate School and the candidate's committee.

Ordinarily, credit is not allowed for graduate courses (including transfers) or foreign language examinations that are more than six years old at the date of the preliminary examination. Similarly, credit will not be allowed for a preliminary examination that is six years old at the date of the final examination. In cases of exceptional merit, however, the Dean of the Graduate School may extend these limits. Should the six year limits be exceeded, the student's department must submit to the Dean specific requirements for revalidating credits.

Preliminary Examination. A student is not accepted as a candidate for the Ph.D. degree until the preliminary examination has been passed. The examination ordinarily covers both the major field and related work. In the summer a preliminary examination may be scheduled only between the opening and closing dates of the summer session.

A student who fails the preliminary examination may apply, with the consent of the supervisory committee and the Dean of the Graduate School, for the privilege of a second examination to be taken no earlier than three months after the date of the first. Successful completion of the second examination requires the affirmative vote of all committee members. Failure on the second examination will render a student ineligible to continue a program for the Ph.D. degree at Duke University.

The Dissertation. The dissertation is expected to be a mature and competent piece of writing, embodying the results of significant and original research.

One month before the dissertation is presented and no later than *February 1* preceding the May commencement, *August 1* for a September degree, and *December 1* for a December degree, the student must file with the Dean of the Graduate School, on the official form available in the Graduate School office, the title of the dissertation. This title must receive the written approval of both the Director of Graduate Studies of the student's major department and the professor who directs the dissertation.

The basic requirements for preparing the dissertation (type of paper, form, and binding) are prescribed in the *Guide for the Preparation of Theses and Dissertations*, copies of which are available in the Graduate School office.

The dissertation must be completed to the satisfaction of the professor who directs the dissertation, members of the student's advisory committee, and the Dean of the Graduate School. Four typewritten copies, bound in snap binders which may be secured through the Graduate School office, must be submitted to the Dean of the Graduate School on or before *April 1* preceding the May commencement, one week before the end of the Duke summer session for a September degree, or one week before the end of the fall semester for a December degree. The dissertation must be submitted to the Graduate School office at least seven days before the scheduled date of the student's examination.

All doctoral dissertations are published on microfilm through University Microfilms, Ann Arbor, Michigan. Authors may copyright them if they wish. Abstracts are published in *Dissertation Abstracts International*.

All copies of the dissertation will remain in snap binders until after the final examination. Two extra copies of the abstract (not more than 350 words long) are submitted when the dissertation is first presented to the Graduate School office. A nonrefundable fee of $40 is charged for microfilming. If copyright is desired, an additional fee of $20 is charged. The original and two copies will be bound at a cost of $22.50. A deposit of $5 is collected for each snap binder on loan from the library used for dissertation copies that will not be bound.

Final Examination. The final examination is normally administered by the five members of the supervising committee, but it may be administered by four members of the committee if the member representing the related field is present. In either case, successful completion of the final examination requires at least four affirmative votes. The final oral examination shall be primarily on the dissertation; however, questions may be asked in the candidate's major field. Except in unusual circumstances approved by the Dean, a final examination will not be scheduled when the University is not in session.

A student who fails the final examination may be allowed to take it a second time, but no earlier than six months from the date of the first examination. Permission to take the second examination must be obtained from the professor who directed the dissertation and from the Dean of the Graduate School. Failure to pass the second examination renders the student ineligible to continue work for the Ph.D. degree at Duke University.

Deposit of the Dissertation. After passing the examination, candidates bring to the Graduate School office the original and the first two copies of the dissertation, properly signed. At this time they sign the microfilming agreement and pay microfilming and copyright fees.

Commencement

Graduation exercises are held once a year, in May, when degrees are conferred on and diplomas are issued to those students who have completed requirements by the end of the spring. Those who complete degree requirements by the end of the fall or by the end of a summer term receive diplomas dated December

30 or September 1, respectively. There is a delay in the mailing of September and December diplomas because diplomas cannot be issued until they are approved by the Academic Council and the Board of Trustees.

Standards of Conduct

Duke University expects and will require of all its students cooperation in developing and maintaining high standards of scholarship and conduct.

Students are expected to meet academic requirements and financial obligations, as specified elsewhere in this bulletin, in order to remain in good standing. Certain nonacademic rules and regulations must be observed also. Failure to meet these requirements may result in dismissal by the appropriate officer of the University.

The University wishes to emphasize its policy that all students are subject to the rules and regulations of the University currently in effect or which, from time to time, are put into effect by the appropriate authorities of the University. Students, in accepting admission, indicate their willingness to subscribe to and be governed by these rules and regulations and acknowledge the right of the University to take such disciplinary action, including suspension and/or expulsion, as may be deemed appropriate for failure to abide by such rules and regulations or for conduct adjudged unsatisfactory or detrimental to the University. University authorities will take action in accordance with due process.

Judicial Code and Procedures. In the spring of 1971, the Graduate School community ratified and adopted the following official judicial code and procedures:

I. Graduate School Judicial Code and Procedures

A. A student, by accepting admission to the Graduate School of Duke University, thereby indicates willingness to subscribe to and be governed by the rules and regulations of the University as currently are in effect or, from time to time, are put into effect by the appropriate authorities of the University, and indicates willingness to accept disciplinary action, if behavior is adjudged to be in violation of those rules or in some way unacceptable or detrimental to the University. However, a student's position of responsibility to the authorities and the regulations of the University in no way alters or modifies responsibilities in relation to civil authorities and laws.

B. A graduate student at Duke University stands in a primary and unique relation of responsibility to the faculty in the major department, the faculty upon whose recommendation a graduate degree will or will not be awarded to the student. In matters which involve or may affect the student's intellectual or professional life, the student is directly responsible to this department and its representatives, and such matters should primarily be handled by the department.

C. Actions which appear to conflict with University-wide rules and regulations will fall under the jurisdiction of the University Judicial Board.

D. A student may elect to have the Dean of the Graduate School hear matters related to the student's conduct in addition to or instead of faculty members from the student's major department, or may elect to have such matters reviewed and judged by a judicial board instead of the Dean of the Graduate School or members of the faculty in the major department. (The constitution and procedure of the judicial board are detailed below.)

E. The Director of Graduate Studies in the student's major department may request that a student's actions be reviewed by the Judicial Board or by the Dean of the Graduate School.

II. The Graduate School Judicial Board

A. *Composition.* The Graduate School Judicial Board shall have five members, serving for a period of two years: two students selected from the student body, two members of the Graduate Faculty appointed by the Executive Committee of the Graduate School, and one Associate or Assistant Dean appointed by the Dean of the Graduate School. The Board shall elect one of its members as Chairman. The Board shall have at its service a recording secretary to keep minutes of the hearings and of the Board's actions in a permanent, confidential record book. The Board will be constituted in order to hear cases in which the accused is a student currently enrolled in the Graduate School and which have been referred to it by the Director of Graduate Studies in the student's department, by the Dean of the Graduate School, or by the student himself.

B. *Preliminary Procedures.* If a student requests a hearing by the Judicial Board it must be done in writing, allowing its Chairman at least seventy-two hours to convene the Board. In addition, the Chairman shall not convene the Board until seventy-two hours after being asked to convene the Board. It is the responsibility of the Chairman of the Judicial Board fully to inform its members concerning the case and the reasons the case has been referred to the Board; and to prepare a written summary of this information for the Board, the Dean, and the student.

C. *Procedural Safeguards for the Hearing.* The Accused has the right to challenge any member of the Judicial Board on grounds of prejudice. If the Board decides to excuse one or more of its members for reasons given by the Accused, it shall consult with the Dean about the need for replacements. The Accused may choose an Adviser to assist in the defense. The Accused may also produce witnesses (including no more than two character witnesses), introduce documents, and offer testimony. A person having direct knowledge relevant to a case being heard by the Board is a material witness. The Judicial Board may request the appearance of material witnesses. The Board shall also request, upon written request of the Complainant or the Accused, the appearance of material witnesses. Witnesses shall be notified of the time, place, and purpose of their appearance. The Accused has the right to examine the written statement of any witness relevant to the case at least seventy-two hours before the hearing. The Accused has the right to be faced with any witness who has given a statement relevant to the case at the hearing if the witness's attendance can be secured.

The hearing will be conducted in private unless the Accused requests an open hearing. If any objection is raised to conducting an open hearing in any particular case, the Judicial Board shall decide the issue by majority vote. If the decision is made not to hold an open hearing, the Accused shall be informed in writing of the reasons for the decision.

The Judicial Board shall consider only the report of the Chairman, documents submitted into evidence, and the testimony of witnesses at the hearing in reaching its decisions.

D. *Conduct of the Hearing.* The hearing of any case shall begin with a reading of the charge by the Chairman in the presence of the Accused. The Accused shall then plead guilty or not guilty or move to terminate or postpone the hearing. The Accused may qualify a plea, admitting guilt in part and denying it in part. The Accused may not be questioned for more than one hour without recess.

At any time during the hearing, the Accused or the Judicial Board may move to terminate or to postpone the hearing or to qualify the plea or to modify its charge.

Pending verdict on charges (including appeal) against the Accused, status as a student shall not be changed, nor the right to be on campus or to attend classes suspended, except that the Chancellor or Provost may impose an interim suspension upon any member of the University community who demonstrates, by conduct, that continued presence on the campus constitutes an immediate threat to the physical well-being or property of members of the University community or the property or orderly functioning of the University.
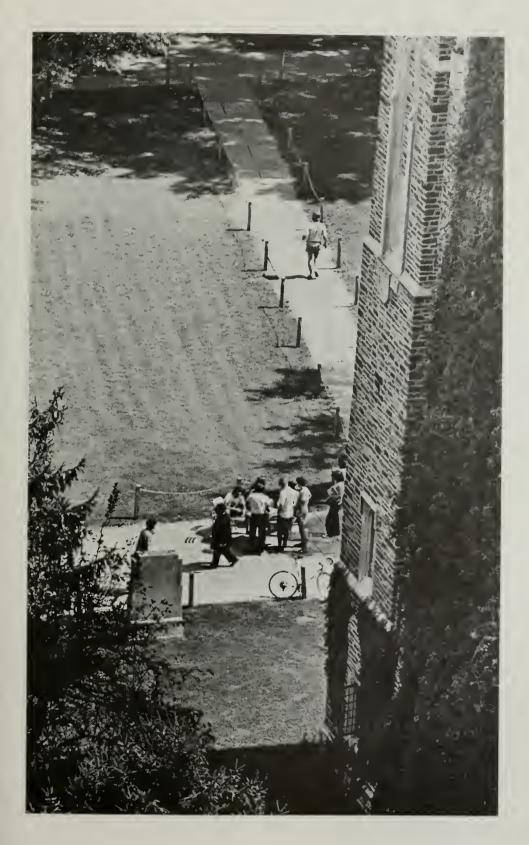
E. *Sanctions and the Verdict.* The Graduate School Judicial Board shall have the power to impose the following penalties: expulsion, dismissal from the University with the recommendation that the person never be readmitted; suspension, dismissal from the University and from participation in all University activities for a specified period of time, after which the student may apply for readmission; disciplinary probation, placing the student on a probationary status for a specified period of time, during which conviction for violation of any regulation may result in more serious disciplinary action; restitution, payment for all, or a portion of property damage caused during the commission of an offense. Restitution may be imposed by itself or in addition to any of the other penalties. The Judgment shall consist of a finding of guilty or not guilty of the charge and, when the Accused is found guilty, a statement of the punishment assessed. On all questions, including the verdict and the finding of guilty or not guilty, the Board shall be governed by a majority vote. The Judicial Board may decide to rehear a case in which significant new evidence can be introduced. In addition, the defendant may request an appeal.

F. *Appeals.* The appellant may submit to the Dean a written statement containing the grounds for appeal and arguments. In such cases, the Dean should determine if the appeal should be granted, and the Dean can hear the case, or refer it to the appropriate faculty in the student's department or to the Judicial Board.
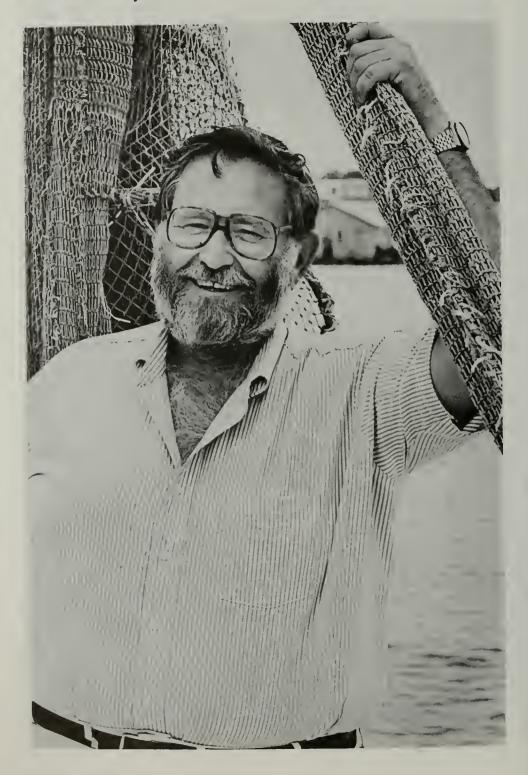
An appeal shall be granted on the following grounds: procedural error substantially affecting the rights of the accused; incompatibility of the verdict with the evidence; excessive penalty not in accord with "current community standards"; new evidence of a character directly to affect the judgment but on which the original tribunal had refused a new hearing.

III. Amendment and Construction

This Judicial code and procedure and this constitution and procedure for the Graduate School Judicial Board may be amended at any time with due notice or publication by consent of the Dean, the Executive Committee, and the graduate students. Questions and problems not answered or anticipated by the foregoing may be resolved by the use of other existing institutions or by amendment.

Courses of Instruction

Course Enrollment

Courses numbered 200-299 are sometimes open to qualified undergraduate students who have received permission of the instructor and the Director of Graduate Studies. Undergraduate students are not permitted in any courses above 300.

In general, courses with odd numbers are offered in the fall semester, those with even numbers in the spring semester. Double numbers separated by a hyphen indicate that the course is a year course and usually must be continued throughout the year if credit is to be received. A student must secure written consent from the instructor in order to receive credit for either semester of a year course. Double numbers separated by a comma indicate that although the course is a year course, credit may be received for either semester without special consent. Ordinarily, courses which bear no date are offered every year.

In each department the number 399 is reserved to designate special (individual) readings in a specified area and supervised by a regular member of the graduate staff, with credit of 1-3 units each registration, only one course per registration, and 9 units maximum in three successive registrations. The course is restricted to resident master's and doctoral programs, must have a completion exercise, and must carry a grade.

The symbol *S*, suffixed to a course number, identifies that course as a seminar.

Anatomy

Professor Robertson, *Chairman* (466 Sands); Professor Moses, *Vice Chairman* (355 Sands); Professor Counce, *Director of Graduate Studies* (356A Sands); Professors Cartmill, Erickson, Hall, Hylander, Kay, Nicklas, Reedy and Simons; Associate Professors Corless, Effmann, Longley, MacPhee, McIntosh, and Tyrey; Assistant Professors Cant, Costello, Crain, Fitzpatrick, Garrett, Jakoi, Lamvik, Lin, Saling, Schachat, and Smith; Professor Emeritus Everett; Associate Professor Emeritus Duke; Associate Medical Research Professor Taylor; Assistant Medical Research Professors Beall, Kopf, McCaslin, Raczkowski, and Schweitzer; Lecturer Diamond

The Department of Anatomy offers graduate work leading to the Ph.D. degree. A common focus on the interrelations of biological structure and function characterizes the research of the anatomy faculty, although three general departmental subdivisions are recognized: biophysical, cellular, and molecular biology; neurobiology; and physical anthropology, functional morphology, and primate evolution.

The department offers doctoral training programs designed to produce teachers and research scientists competent in a broad range of the anatomical sciences, and students with a wide variety of backgrounds and interests in the biological sciences can be accommodated within the Ph.D. program. A reading knowledge of one foreign language is required of all doctoral students in anatomy. All students participate in the core anatomical science courses (Anatomy 305, 307, 309) and gain experience in teaching over the range of departmental interests. The anatomy department is also a participating member of several interdisciplinary training programs, such as those in genetics, cell and molecular biology, neurobiology, pharmacology, and biological systems. All students are encouraged to round out their training by drawing upon anatomy courses as well as those offered by other departments in the University. Laboratories within the department are equipped for and actively support research in several areas. For further information contact the Director of Graduate Studies.

216S. Biological Psychology. C-L: Psychology 216S. 3 units. *W. C. Hall and Diamond*

217. Structure and Function of Visual Photoreceptors. A detailed study of available structural, biochemical, spectroscopic, and physiological data from retinal photoreceptors. Emphasis on molecular structure of vertebrate photoreceptor membranes, effects of bleaching on rhodopsin molecules, and initiation of neural information after photon absorption. Lectures, seminars, and demonstrations. Offered alternate years. Prerequisite: consent of instructor. Credit to be arranged; maximum 4 units. *Corless*

219. Molecular and Cellular Bases of Differentiation. A multidisciplinary approach stressing the molecular, cellular, and genetic processes involved in differentiation in eukaryotes. C-L: Biochemistry 219, Microbiology and Immunology 219, Pathology 219, and Physiology 230. 3 units. *Counce and staff*

220. Developmental Biology. General concepts and problems in modern developmental biology with special emphasis on cellular and subcellular events and on developmental genetics. Experimental studies in a wide range of both plant and animal species will be discussed. Intellectual continuity between early classical studies in experimental embryology and present-day developmental biology will be stressed. 3 units. *Counce*

246S. The Primate Fossil Record. Evolution of humans and other primates as inferred from fossil remains. Prerequisite: a course in human evolution. C-L: Anthropology 246S. 3 units. *Simons*

259. Molecular Biology I: Protein and Membrane Structure/Function. C-L: Biochemistry 259, Microbiology and Immunology 259, and the University Program in Cell and Molecular Biology. 3 units. *Erickson and staff*

266S. Comparative Neurobiology. C-L: Psychology 266S. 3 units. *Diamond and W. C. Hall*

269. Advanced Cell Biology. C-L: Botany 269, Microbiology and Immunology 269, the University Program in Cell and Molecular Biology, and Zoology 269. 3 units. *McIntosh and staff*

286. Electron Microscopy and Related Techniques. Lectures and laboratories on methods of ultrastructure research. Fundamentals of optics; the light microscope, phase, polarizing, and interference microscopy. Basics of electron microscopy, staining, sectioning, and replication techniques. Optical and computer image processing. Introduction to X-ray diffraction theory and apparatus in biological structure determination. Prerequisites: calculus and one year each of physics and general chemistry or consent of instructor. Offered in alternate years or on demand. 4 units. *Longley*

292. Topics in Morphology and Evolution. Various aspects of vertebrate morphology and evolution will be discussed. Specific focus will vary from year to year, but topics will include major historical approaches to the interpretation of morphology; the evolution, development, and function of specific morphological structures; and patterns of vertebrate evolution. Prerequisite: consent of instructor. 1-3 units. *Smith*

301. Anatomy of the Limbs. This course concentrates on the musculoskeletal anatomy of the limbs and limb girdles. Emphasis is on detailed dissection of the extremities, with a minor focus on clinical applications. Course primarily intended for advanced graduate students in physical therapy. Prerequisite: consent of instructor. 1-3 units. *MacPhee*

305. Gross Human Anatomy. Includes complete dissection of a cadaver; laboratory work is supplemented by conferences which place emphasis upon biological and evolutionary aspects. Prerequisites: adequate background in biology, including comparative anatomy and embryology and written consent of instructor. Required of entering graduate students in anatomy; by arrangement, may extend into second semester. 3 units. *Staff*

307. Microscopic Anatomy. Lectures on structural organization of different tissues and organs, as determined by light and electron microscopy with emphasis on the relation of structure to function at the cellular level. The laboratory provides practical experience with light microscopy, studying and analyzing our extensive slide collection of mammalian tissues. 3 units. *Erickson and staff*

309. Basic Neurobiology. (Previously cross-listed Physiology 201.) An integrated interdepartmental course designed for the first year medical students and other professional students who need a core course on the morphology and functions of the mammalian nervous system. Lectures, laboratory demonstrations, clinical conferences and lecture conferences during the month of January only. Prerequisites: ANA 305, ANA 307, BCH 200 and PHS 200 or equivalents. C-L: Physiology 202. 4 units. *Hall, Somjen, and staff*

310. Frontiers in Neurobiology. Course consists of readings and student and faculty presentations of current problems in neurobiology. Prerequisite: consent of instructors. 3 units. *Cant, Hall, and Lin*

312. Research. Individual investigations in the various fields of anatomy. Laboratories in which a student may work include: three electron microscopy laboratories headed by Moses, Reedy, and Robertson with emphasis respectively on the fine structure and cell biology of chromosomes and associated structures, molecular structure and function of muscle, and biophysical studies of cell membranes and nervous tissue; physical anthropology laboratories and the primate facility under Simons, Cartmill, Hylander, MacPhee, Kay, and Smith concentrating on biomechanics, cytogenetics, comparative anatomy, and primate evolution and behavior; neuroanatomy laboratories under Hall, Cant, Lin, and Diamond emphasizing structural correlates of behavior and learning; neuroendocrinology laboratories under Everett and Tyrey with emphasis on brain mechanisms regulating reproductive functions of the pituitary gland; developmental and cellular biology laboratories under Counce with emphasis on developmental genetics of dipteran embryos, under Jakoi with emphasis on mechanisms for cell surface differentiation, and under Schachat with emphasis on muscle biochemistry and development; and molecular structure laboratories under Longley, Erickson, Taylor, and Corless using a combination of electron microscopy, X-ray diffraction, and optical and computer methods of image analysis to study respectively fibrous proteins, microtubules, and photoreceptor membranes. Prerequisite: consent of instructor. Credit to be arranged; maximum 6 units. *Staff*

313, 314. Anatomy Seminar. Regular meeting of graduate students and staff in which current research problems in anatomy will be presented. 1 unit each. *Staff*

340. Tutorial in Advanced Anatomy. Topics for intensive reading and discussion will be chosen according to the student's interests, related to basic problems in biophysics, cytology, endocrinological control, growth and development, neuroanatomy, physical differentiation, and evolutionary origins of functional microsystems. Prerequisite: consent of instructor. Enrollment: maximum 8. Variable units. *Staff*

354. Research Techniques in Anatomy. A preceptorial course in various research methods in anatomy. An interested student might engage in research in one of the following: anthropology, electron microscopy, X-ray diffraction, chromosome analysis, developmental biology, primate behavior, primate anatomy, and stereotactic approaches to neuroendocrinology and neuroanatomy. Other topics may be arranged. Prerequisite: consent of instructor. Credit to be arranged. *Staff*

370. Neurobiology I. C-L: Pharmacology 370 and Physiology 370. 3 units. *Moore and staff*

418. Reproductive Biology. The lecture material in each section of the course is followed by seminar presentations which will contribute to Anatomy 424, a corequisite for the course. C-L: Physiology 418. 2 units. *Anderson, Schomberg, and Tyrey*

424. Seminar in Reproductive Biology. Can be taken independently or corequisite with Anatomy 418. C-L: Physiology 424. 1 unit. *Anderson, Schomberg, and Tyrey*

COURSES CURRENTLY UNSCHEDULED

219S. Seminar

238. Functional and Evolutionary Morphology of Primates

288S. The Cell in Development and Heredity

302. Advanced Topics and Research Seminar in Smooth and Striated Muscle

Anthropology

Professor Fox, *Chairman* (114 Social Sciences); Associate Professor Smith, *Director of Graduate Studies* (125 Social Sciences); Professors Cartmill, O'Barr, and Simons; Associate Professors Apte, Glander, Quinn, and Smith; Assistant Professors Domínguez, Trouillot, Weller, and Zagarell; Professor Emerita Friedl; Professor Emeritus La Barre; Adjunct Associate Professors Kay and Stack; Visiting Assistant Professor Wright

The department offers graduate work leading to the Ph.D. degree in anthropology. Applicants for admission should submit scores on the Graduate Record Examination Aptitude Test. Admission to the program is not contingent on previous anthropological course work or any other specific program of study at the undergraduate level.

The department offers a program of specialization in social/cultural anthropology and a program of specialization in physical anthropology. The emphasis of the social/cultural anthropology program is the application of a theoretical and comparative perspective to research in complex societies. Within this perspective, a wide range of interests is represented in the department. The emphasis of the physical anthropology program is primate evolution; areas of concentration include comparative morphology of human and nonhuman primates and primate social behavior.

Curriculum is tailored to the individual student's background, academic needs, and research goals; pursuit of relevant cross-disciplinary study, within and outside the department, is expected. However, a modest number of courses is required of students in both programs. A reading knowledge of one foreign language is required of all doctoral students in anthropology. Candidates for the Ph.D. degree must demonstrate competence in their chosen subfield of specialization and knowledge of the broad theoretical perspectives, from all relevant disciplines, which inform their area of concentration.

Further details of the graduate program in anthropology, the departmental facilities, the staff, and various stipends available are described in the *Guidelines for Graduate Students in Anthropology* which may be obtained from the Director of Graduate Studies, Department of Anthropology.

For Seniors and Graduates

201S. Marxism and Anthropology. The interaction of Marxist and anthropological theory over the last half century; particular attention to evolution, historical transformation, mode of production, labor processes, culture, ideology, and consciousness. 3 units. *Smith*

204S. The Anthropology of Cities. Organization and behavior in urban centers from an evolutionary perspective; cross-cultural analysis of cities. Prerequisite: Anthropology 94. 3 units. *Fox or Smith*

206S. Current Theoretical Schools in Anthropology. The theoretical schools since World War II, including cultural materialism and neo-Marxism, structuralism, cognitive anthropology, cultural analysis and symbolic anthropology, transactional analysis, and sociobiology. Prerequisite: Anthropology 94 or graduate standing or permission of instructor. 3 units. *Apte, Domínguez, Fox, O'Barr, Quinn, Smith, Trouillot, or Weller*

211S. Ethnography of Communication. History of the mutual influence of linguistics and anthropology leading to the development of ethnography of speaking, ethnoscience, structuralism, and sociolinguistics. Topics vary each semester. Prerequisite: Anthropology 111 or 119 or consent of instructor. 3 units. *Apte, Domínguez, O'Barr, or Weller*

215S. The Anthropology of Women: Theoretical Issues. Topic to be selected each semester from: gender ideology, women and work, gender inequality, the history of feminist anthropology, or others. C-L: Women's Studies. 3 units. *Domínguez, Quinn, Smith, or Trouillot*

220S. The Cultural Construction of Gender. Understandings of women, men and the relations between them in other societies and our own. Directed research in American society. C-L: Women's Studies. 3 units. *Quinn*

228S. Slavery and Society. Western and non-Western systems of slavery and their effects on social organization, self-concepts, and race relations. 3 units. *Domínguez*

234S. Political Economy of Development: Theories of Change in the Third World. C-L: History 234S, Political Science 234S, and Sociology 234S. 3 units. *Bergquist, Fox, Gereffi, Smith, Trouillot, and Valenzuela*

239. Culture and Ideology. Major theories about the relationship between ideologies and social/economic systems. Readings from the works of Marx, Weber, Gramsci, Althusser, Geertz, and others. 3 units. *Trouillot or Weller*

241. The Rise of Civilization in Mesopotamia and Iran. An introductory survey of the major stages of development from the beginnings of agriculture to the collapse of the early state-system (10,000–1,800 B.C.E.). Archaeological and

textual evidence, focusing on the rise of the Mesopotamian state-system, the nature of that system, and the mechanisms leading to its collapse. C-L: Women's Studies. 3 units. *Zagarell*

243S. Theory and Method in Archaeology. Techniques of geochronology, environmental reconstruction, sociocultural reconstruction, and statistical analyses applied to problem areas in archaeology. Prerequisite: Anthropology 166 or consent of instructor. 3 units. *Zagarell*

244S. Primate Behavior. Social behavior of prosimians, monkeys, and apes and the evolutionary development of primates. 3 units. *Glander*

246S. The Primate Fossil Record. Evolution of humans and other primates as inferred from fossil remains. Prerequisite: a course in human evolution or consent of instructor. C-L: Anatomy 246S. 3 units. *Simons*

251S. American Marriage: A Cultural Approach. Individual research on the American cultural model of marriage. Collection, transcription, and analysis of how individuals adapt it to understanding their own experiences. 3 units. *Quinn*

255S. Heroes and Heroics: Culture and the Individual. Can great men or women change the course of cultures? Or are even those we call geniuses and heroes simply carriers of their culture? The relationship between individuals and their cultures as portrayed in anthropology and related disciplines. Various approaches to the lives of selected heroes, using M.K. Gandhi as an exemplar. 3 units. *Fox*

258S. Symbols in Society. Symbolic action and expressive culture among tribal, peasant, and industrial societies. Approaches emphasized are functionalism, symbolic interaction, structuralism, and cultural interpretation. 3 units. *Apte, Domínguez, Trouillot, or Weller*

267. Cognitive Anthropology. The organization of culturally shared knowledge; cognitive tasks such as categorizing, decision making, problem solving, and reasoning. 3 units. *Quinn*

272S. Marxism and Feminism. Introduction to the theoretical literature and debates linking Marxism and Feminism. Prerequisite: consent of instructor. C-L: Women's Studies. 3 units. *Smith*

280S, 281S. Seminar in Selected Topics. Special topics in methodology, theory, or area. Prerequisite: consent of instructor. 6 units. *Staff*

282S. Canada. C-L: History 282S, Political Science 282S, and Sociology 282S. 3 units. *Leach*

For Graduates

330S, 331S. Theories in Sociocultural Anthropology. A two-semester seminar in anthropological theory, in which the modern currents and debates in the field are examined and discussed. Particular topics to be chosen by the instructors. 6 units. *Staff*

393. Individual Research in Anthropology. Supervision and guidance of A.M. thesis preparation, Ph.D. dissertation preparation, or other intensive research on a selected problem. 3 units. *Staff*

COURSES CURRENTLY UNSCHEDULED

205. The Anthropology of Anthropology

237S. Interpretations of Kinship

275S. Inequality in Precapitalist Societies

334. Topics in Physical Anthropology

Art and Art History

Professor Goffen, *Chairman*; Professor Spencer, *Director of Graduate Studies* (112A East Duke); Associate Professors Pressly and Wharton; Assistant Professors Bruzelius, Castriota, and Sund; Professor Emeritus Markman

Graduate work in the Department of Art and Art History is offered leading to the A.M. degree in art history and is designed to provide basic training in the history of art with specialization in a given field selected by the student after consultation with and approval by the Director of Graduate Studies. Prospective students should present a minimum of 24 semester hours of undergraduate work in the history of art. In special cases a student who does not fulfill this prerequisite may be required to attend prescribed undergraduate courses. A reading knowledge of one foreign language (preferably German) is required; candidates who do not meet this requirement upon admission to the program are expected to do so by the end of their first term in residence.

The program for the A.M. degree in art history consists of 30 units as follows: 12 units in art history; 6 units in an approved minor; 6 units in the major or minor, or other approved subject; and 6 units in thesis. A written thesis is required.

For Seniors and Graduates

221S. Studies in Roman Art. Selected topics in the art and architecture of Late Republican and Imperial Rome. Prerequisite: consent of instructor. 3 units. *Castriota*

230S. Medieval and Byzantine Art and Architecture. Conceptual, institutional, or stylistic topics. Subject varies from year to year. Prerequisite: consent of instructor. C-L: Medieval and Renaissance Studies. 3 units. *Bruzelius or Epstein*

232S. Romanesque and Gothic Art and Architecture. Analysis of an individual topic. Subject varies from year to year. Prerequisite: consent of instructor. C-L: Medieval and Renaissance Studies. 3 units. *Bruzelius*

234. Medieval Architecture. The development of medieval architecture through the mid-fourteenth century. Emphasis on churches, with some discussion of castles and fortifications, town planning, and domestic architecture. 3 units. *Bruzelius*

235. Gothic Cathedrals. Major monuments of Gothic architecture in the twelfth and thirteenth centuries on the continent and in England with concentration on the great cathedrals of France. 3 units. *Bruzelius*

241. Fifteenth-Century Italian Art. Painting, sculpture, and architecture from Masaccio, Donatello, and Brunelleschi to Leonardo. Emphasis on the art of Florence. 3 units. *Goffen or Spencer*

242S. Studies in Italian Renaissance Art. Specific problems dealing with iconography, style, or an individual master from ca. 1300 to 1600. Subject varies from year to year. Prerequisite: consent of instructor. C-L: Medieval and Renaissance Studies. 3 units. *Goffen and Spencer*

243S. Studies in Northern Art. Selected topics such as the Antwerp workshops of the sixteenth century, picturing in Haarlem at the turn of the seventeenth century, or Rubens and Rembrandt. 3 units. *Melion*

251. Italian Baroque Art. Seventeenth-century painting, sculpture, and architecture. 3 units. *Melion*

252. Northern Baroque Painting. Seventeenth-century Flemish and Dutch painting, with emphasis on the art of Rubens and Rembrandt. 3 units. *Melion*

261S. Studies in Romanticism. Examination of the work of a single artist or the development of a specific theme or movement within the period 1760 to 1850. 3 units. *Pressly*

262S. Studies in Nineteenth-Century Art. Focus on a major artist, movement, or trend in nineteenth-century art. Prerequisite: consent of instructor. 3 units. *Pressley or Sund*

274. The History of Impressionism. The evolution of the impressionist movement and the works of its major masters. Particular attention will be paid to Monet, Degas, Cézanne, Pissarro, and Renoir. 3 units. *Pressly or Sund*

275. Surrealism. The surrealist movement that flourished in Paris between the World Wars; its origins, aims, and major adherents—such as the artists Miró, Magritte, Tanguy, and Dali—examined in the context of surrealist literature, theory, and politics. 3 units. *Sund*

276S. Problems in Modern Art. Selected topics in modern art before 1945, with emphasis on major movements or masters. Prerequisite: consent of instructor. 3 units. *Sund*

278. Twentieth-Century Criticism. Twentieth-century art through the writings of its major proponents from Apollinaire and Roger Fry through Meyer, Schapiro, and Clement Greenberg to present-day theorists of postmodernism. The definition of modernism and the role of the critic as advocate, mediator, arbiter, and prophet of contemporary trends. 3 units. *Staff*

293S. Methods in Art History. Approaches to the study of works of art, including connoisseurship, iconology, and stylistic analysis. Open to art majors, seniors, and qualified juniors only. 3 units. *Staff*

294, 295. Special Problems in Art History. Individual study and research. 6 units. *Staff*

COURSES CURRENTLY UNSCHEDULED

220S. Greek Painting

227. Early Christian Culture: Evidence of Art and Literature

231. Byzantine Art and Architecture

240. Italian Art

245. Sixteenth-Century Italian Art

248. Art of Northern Europe in the Fifteenth and Sixteenth Centuries

249. Death in Art

277S. Contemporary Art

279S. Problems in Modern Architecture

Asian Languages

The courses are offered as an enrichment for students interested in the South Asian subcontinent and may be taken as a general elective by advanced undergraduate students. No major work is offered in Hindi-Urdu.

COURSES CURRENTLY UNSCHEDULED

Hindi-Urdu 200, 201. Special Studies in South Asian Languages

Hindi-Urdu 203. Studies in Commonwealth Literature

For courses in Chinese and Japanese, see *Bulletin of Duke University: Undergraduate Instruction.*

Biochemistry

Professor Hill, *Chairman* (255 Nanaline H. Duke); Professor Webster, *Director of Graduate Studies* (157-B Nanaline H. Duke); Professors Bell, Fridovich, Gross, Guild, Kamin, Kredich, Lefkowitz, McCarty, Modrich, Rajagopalan, Siegel and Spicer; Associate Professors Greene, Greenleaf, Hsieh, B. Kaufman, D. Richardson, Sage, Steege, and Sullivan; Assistant Professors Blackshear, Hershfield, R. Kaufman and Schlossman; Professor Emeritus Bernheim; Associate Medical Research Professor J. Richardson

Graduate work in the Department of Biochemistry is offered leading to the Ph.D. degree. Preparation for such graduate study may take diverse forms. Undergraduate majors in chemistry, biology, mathematics, or physics are welcome, but adequate preparation in chemistry is essential. Graduate specialization areas include protein structure and function, crystallography of macromolecules, nucleic acid structure and function, lipid biochemistry, membrane structure and function, molecular genetics, enzyme mechanisms, and neurochemistry. The Division of Genetics of the department, in cooperation with the University Program in Genetics, offers biochemistry students the opportunity to pursue advanced research and study to fulfill the requirements for the Ph.D. degree.

200. General Biochemistry. An introductory survey of fundamental aspects of biochemistry with emphasis on the structure of macromolecules, mechanism of enzyme action, metabolic pathways, biochemical genetics, and the structure and functions of special tissues. Designed for medical students; graduate students only with consent of instructor. 4 units. *Hill and staff*

209, 210. Independent Study. A tutorial designed for students who are interested in either a laboratory or a library project in biochemistry. Credit to be arranged. C-L: Marine Sciences 209. *Staff*

215. Genetic Mechanisms. Genetic mechanisms in molecular terms emphasizing gene function, segregation, and regulation in procaryotes and eucaryotes. Systems covered include bacterial viruses, bacteria, plasmids, cellular organelles, and selected lower and higher eucaryotes. Prerequisite: introductory biochemistry. Course material will be drawn from original literature. C-L: The University Program in Genetics. 3 units. *Webster and staff*

219. Molecular and Cellular Bases of Differentiation. C-L: Anatomy 219, Microbiology and Immunology 219, Pathology 219, and Physiology 230. 3 units. *McCarty and staff*

219S. Seminar. Optional seminar in conjunction with Biochemistry 219. *McCarty*

222. Structure of Biological Macromolecules. Introduction to the techniques of structure determination by X-ray crystallography and study of some biological macromolecules whose three-dimensional structures have been determined at high resolution. 2 units. *Richardson*

224. Biochemistry of Development and Differentiation. The course represents an extension of topics covered in the first semester course, Biochemistry 219. Emphasis will be on the control of transcription and translation of messenger RNA in mammalian cells. These studies include gene amplification, postsynthetic modifications of chromosomal proteins, as a result of hormone induction. Specific systems will include the development of the mammary gland, the pancreas, and the chick oviduct. 2 units. *McCarty*

227. Introductory Biochemistry I: Intermediary Metabolism. Prerequisite: organic chemistry. C-L: Botany 227. 3 units. *Staff*

245L. Macromolecules, Ecology, and Evolution. The structure and function of protein and nucleic acid molecules with particular emphasis on the application of molecular techniques to questions in ecological, systematic, and evolutionary theory. C-L: Marine Sciences 245L. 3 units. *Sullivan*

259. Molecular Biology I: Protein and Membrane Structure/Function. C-L: Anatomy 259, Microbiology and Immunology 259, and the University Program in Cell and Molecular Biology. 3 units. *Staff*

265S, 266S. Seminar. Topics and instructors announced each semester. C-L: Marine Sciences. 2 units or variable. *Staff*

268. Molecular Biology II: Nucleic Acids. C-L: Botany 268, Microbiology and Immunology 268, and the University Program in Cell and Molecular Biology. 4 units. *Modrich and staff*

276. Comparative and Evolutionary Biochemistry. Lectures and discussion of the origin of life, evolution of genetic code, mutation and protein polymorphism, natural selection and protein structure, and comparison of homologous proteins and nucleic acids. Laboratory work involves the purification and characterization of homologous proteins from fish and invertebrates. Techniques include salt fractionation, electrophoresis, ion-exchange and molecular exclusion chromatography, fingerprinting, molecular weight determination, amino acid composition, and other related approaches. Prerequisite: consent of instructor. Offered at Beaufort. C-L: Marine Sciences 276. 6 units. *Sullivan*

286. Current Topics in Immunochemistry. The structure, function, and specificity of antibodies. Immunogenicity and tolerance with special emphasis on current theories of the diversity and synthesis of antibody molecules. 2 units. *Sage*

288. The Carbohydrates and Lipids of Biological Systems. The subjects will be considered in the following two general categories: *(a)* the relationship between chemical structure and biological function, and *(b)* biosynthesis and catabolism. 2 units. *Kaufman*

291. Physical Biochemistry. Principles of thermodynamics, hydrodynamics, spectroscopy, and X-ray diffraction and scattering are applied to biological systems. Biological molecules and macromolecules in both soluble and crystalline states are discussed. Prerequisite: undergraduate physical chemistry, including solution thermodynamics, kinetics, introductory quantum mechanics, and introductory crystallography. 3 units. *Hsieh and staff*

296. Biological Oxidations. A lecture, conference, and seminar course on the mechanism of electron transport and energy conservation in purified enzymes and in organized systems such as the mitochondrion, the endoplasmic reticulum, and the chloroplast. 2 units. *Siegel and staff*

297. Intermediary Metabolism. Lectures and student presentations on selected topics in the areas of metabolic regulation, bioenergetics, and other subjects of current research interest in metabolism. 3 units. *Siegel and staff*

299. Nutrition. This course examines the experimental basis for the identification and quantification of requirements for calories, macronutrients, and micronutrients (vitamins and minerals); the biochemistry of nutrition with the assessment of nutriture; and the biological effects of deficiency or excess of nutrients. The course seeks to define optimal nutriture and will search for factual bases for common beliefs on nutrition of individuals and populations. Informal lectures and, if possible, student seminars. Prerequisite: a basic biochemistry course or equivalent or consent of instructor. 2 units. *Kamin*

345, 346. Biochemistry Seminar. Required of all biochemistry students. 1 unit each. *Guild and Richardson*

347, 348. Seminar in Toxicology. A weekly research seminar throughout the year is required of participants in the toxicology program. Students, faculty, and invited speakers present their findings. C-L: Pharmacology 347, 348. 1 unit per semester. *Abou-Donia and Lynn*

Botany

Professor W. Culberson, *Chairman* (149 Biological Sciences); Professor Boynton, *Director of Graduate Studies* (145 Biological Sciences); Professors Antonovics, Barber, Osmond, Ramus, Searles, Stone, Strain, White, and Wilbur; Associate Professors Christensen, Knoerr, Schlesinger, and Siedow; Assistant Professors Johnston, Kohorn, Mishler and Vilgalys; Professors Emeriti Anderson, Billings, Hellmers, Kramer, Naylor, and Philpott; Adjunct Professor C. Culberson; Adjunct Associate Professor Patterson

Graduate work in the Department of Botany is offered leading to the A.M. (nonthesis), M.S. (thesis), and Ph.D. degrees. Students entering the graduate program in Botany normally have a broad background in the botanical or biological sciences supplemented with basic courses in chemistry, mathematics, and physics. Biochemistry and physical chemistry are strongly recommended for students interested in molecular areas, and advanced courses in mathematics are recommended for students in population genetics and ecology. Deficiencies may be corrected by taking appropriate courses during the first year of graduate study.

Students in Botany may specialize in a wide variety of areas including anatomy; cellular and molecular biology; evolution; developmental, ecological, molecular, organelle and population genetics; physiology; community, ecosystem, physiological and population ecology; marine biology; and the systematics of algae, fungi, lichens, bryophytes, ferns and flowering plants. Students' programs are tailored to individual needs. A brochure providing detailed information on the Botany Department is available from the Director of Graduate Studies.

205. Genetic Engineering. Molecular aspects of gene expression and cell differentiation; application of recombinant DNA techniques to basic and applied problems. Prerequisites: organic chemistry and cell biology or genetics. 3 units. *Johnston*

209L. Lichenology. Morphology, systematics, and biological and ecological implications of the lichens. Collection and identification of specimens and the use of lichen chemistry in taxonomy. 3 units. *C. Culberson and W. Culberson*

210L. Bryology. Morphological, systematic, and ecological characteristics of mosses and liverworts. 3 units. *Mishler*

212L. Phycology. Morphological and ecological characteristics of common freshwater and marine algae and principles of their classification. 4 units. *Searles*

215L. Primary Productivity in the Seas. The biological flux of carbon in the coastal and open seas involving phytoplankton, seaweeds, seagrasses, and marshgrasses. The contributions of these primary producers to food chain processes and global atmospheric-sedimentary cycles, as well as the ecological consequences of variations in photosynthetic mechanisms. Prerequisites: introductory biology and introductory chemistry. Offered at Beaufort. C-L: Marine Sciences 215L and Zoology 215L. 4 units. *Barber and Ramus*

218. Barrier Island Ecology. Adaptation of plants to barrier island migration and other physical characteristics of the coastal environment. Major emphasis on management of barrier beaches from Maine to Texas and the impact of human interference with natural processes. Field studies. Prerequisite: a course in general

ecology. Offered at Beaufort. C-L: Marine Sciences 218 and Forestry and Environmental Studies 218. 6 units. *Staff*

221L. Mycology. Survey of the major groups of fungi with emphasis on life history and systematics. Field and laboratory exercises. 4 units. *Vilgalys*

222S. Topics in Advanced Mycology. Current research on fungal evolution, genetics, physiology, and ecology. Prerequisites: Botany 221 or consent of instructor. 3 units. *Vilgalys*

225T, 226T. Special Problems. Students with adequate training may do special work in the fields listed below. Credit to be arranged. 1 to 4 units.

1. Genetics. *Antonovics*
2. Biological Oceanography. *Barber*
3. Genetics. *Boynton*
4. Ecology. *Christensen*
5. Lichenology. *W. Culberson*
6. Molecular Botany. *Johnston*
7. Cell Biology. *Kohorn*
8. Systematics and Bryology. *Mishler*
9. Physiological Ecology. *Osmond*
10. Phycology. *Ramus*
11. Ecology. *Schlesinger*
12. Phycology. *Searles*
13. Physiology. *Siedow*
14. Systematics of Flowering Plants. *Stone*
15. Ecology. *Strain*
16. Mycology and Molecular Systematics. *Vilgalys*
17. Anatomy and Morphology of Vascular Plants. *White*
18. Systematics and Taxonomy of Vascular Plants. *Wilbur*

227. Introductory Biochemistry I: Intermediary Metabolism. Chemistry of the constituents of proteins, lipids, carbohydrates, and nucleic acids and their metabolic interrelationships. Prerequisite: organic chemistry. C-L: Biochemistry 227. 3 units. *Staff*

232. Microclimatology. C-L: Forestry and Environmental Studies 232. 3 units. *Knoerr*

234S. Problems in the Philosophy of Biology. Prerequisite: consent of instructor. See C-L: Philosophy 234S. 3 units. *Brandon (philosophy)*

237L. Systematic Biology. Theory and practice of identification, species discovery, phylogeny reconstruction, classification, and nomenclature. Prerequisites: introductory biology and one course in animal or plant diversity. C-L: Zoology 237L. 3 units. *Lundberg and Mishler*

242L. Systematics. Principles of vascular plant taxonomy, with practice in identification of the local flora. Lectures, laboratories, and field trips. Prerequisite: one year of biology. 4 units. *Wilbur*

243S. Classification of Angiosperms. The characteristics and phylogenetic relationships of large and important families of angiosperms with emphasis upon the systems of Cronquist and Thorne. Prerequisite: Botany 142L or equivalent. 3 units. *Wilbur*

245L. Plant Diversity. Major groups of the living plants; their evolutionary origins and phylogenetic relationships. Prerequisite: introductory biology. 4 units. *Mishler, Searles, or Wilbur*

246L. Ecology of Plants. Principles of the relationships between plants and their environments. Structures and processes of ecosystems. Laboratory, lectures, and field trips. Prerequisites: introductory biology and one other course in biology. 4 units. *Christensen, Schlesinger, or Strain*

250L,S. Plant Biosystematics. Descriptive and experimental procedures used to assess systematic implications of vascular plant evolution. Laboratory, discussion, and field-oriented problems. Prerequisites: basic courses in systematics and genetics. 4 units. *Stone*

251L. Plant Physiology. The principal physiological processes of plants including respiration, photosynthesis, water relations, and factors associated with plant morphogenesis. Prerequisites: introductory college biology and one year of chemistry; organic chemistry is desirable. 4 units. *Siedow*

253. Biophysical Plant Physiology. Application of physical principles to such processes as ion transport, water relations, and the interconversion of energy in plant cells. Prerequisites: Botany 151L and Mathematics 32 or equivalent. 3 units. *Siedow*

261. Photosynthesis. Principles of plant photosynthesis: developmental, mechanistic, regulatory, and ecological aspects of the photosynthetic process. Prerequisite: Botany 151L or 251L. 3 units. *Siedow*

265L. Physiological Plant Ecology. The physiological approach to interpreting adaptation in plants, with emphasis on terrestrial seed plants. Prerequisites: Botany 146L and 151L or equivalents. 3 units. *Strain*

266. Plant Population Biology. Theoretical, experimental, and field approaches to plant population dynamics; population growth and regulation; effects of density, competition, and predation. 3 units. *Staff*

267L. Community Ecology. Mechanisms that determine the distribution and abundance of plants and animals: geology, climate, physiography, soils, competition and history. Lectures focus on ecological principles. Seminars and weekend field trips. Prerequisites: an introductory ecology course and consent of instructor. C-L: Zoology 204. 3 units. *Christensen and H. Wilbur (zoology)*

268. Molecular Biology II: Nucleic Acids. C-L: Biochemistry 268, The University Program in Genetics, Microbiology and Immunology 268, and the University Program in Cell and Molecular Biology. 4 units. *Modrich and staff*

269. Advanced Cell Biology. C-L: Anatomy 269, Microbiology and Immunology 269, the University Program in Cell and Molecular Biology, and Zoology 269. 3 units. *McClay and staff*

272. Biogeochemistry. Processes controlling the circulation of carbon and biochemical elements in natural ecosystems and at the global level, with emphasis on soil and surficial processes. Prerequisite: Chemistry 12, Botany 146L, or equivalent. C-L: Geology 272. 3 units. *Schlesinger*

280. Principles of Genetics. C-L: The University Program in Genetics, and Zoology 280. 3 units. *Antonovics, Boynton, and Gillham (zoology)*

283. Extrachromosomal Inheritance. Genetics, biochemistry, and molecular biology of the organelles of eukaryotic cells, and cellular symbionts. Prerequisite: introductory genetics. C-L: The University Program in Genetics, and Zoology 283. 3 units. *Boynton and Gillham (zoology)*

285S. Ecological Genetics. Interaction of genetics and ecology and its importance in explaining the evolution, diversity, and distribution of plants and animals. Prerequisites: Botany 180 and 286 or equivalents. C-L: The University Program in Genetics. 3 units. *Antonovics*

286. Evolutionary Mechanisms. Population ecology and population genetics of plants and animals. Fitness concepts, life history evolution, mating systems, genetic divergence, and causes and maintenance of genetic diversity. Prerequisite:

Zoology 74 or a course in genetics. C-L: The University Program in Genetics, and Zoology 286. 3 units. *Antonovics and H. Wilbur (zoology)*

287S. Macroevolution. Evolutionary patterns and processes at and above the species level. Topics include: species concepts, speciation, diversification, extinction, ontogeny and phylogeny, rates of evolution, and alternative explanations for adaptation and evolutionary trends. Prerequisite: one course in plant or animal diversity. C-L: Zoology 287S. 3 units. *Mishler and Roth (zoology)*

293L. Population Biology. Theoretical approach to population genetics, life table mathematics, life cycle evolution in plants and animals, population dynamics, and regulation. Laboratories emphasize experimental methods. Individual projects and weekend field trips. Prerequisites: calculus, ecology, and consent of instructor. C-L: Zoology 293L. 3 units. *Antonovics and H. Wilbur (zoology)*

295S, 296S. Seminar. Credit to be arranged. *Staff*

300. Tropical Biology: An Ecological Approach. Highly intensive, field-oriented course conducted in Costa Rica under auspices of the Organization for Tropical Studies. For additional information refer to the chapter "Special and Cooperative Programs." 6 to 8 units. *Staff*

330L. Environmental Monitoring and Instrumentation. Methods of measuring and monitoring the earth's physical environment with emphasis on water and air resources. Characteristics and uses of contemporary sensors, measurement and data acquisition systems. Methods of obtaining and processing computer compatible data records. Prerequisite: consent of instructor. C-L: Forestry and Environmental Studies. 4 units. *Knoerr*

359, 360. Research in Botany. Individual investigation in the various fields of botany. C-L: Marine Sciences 359, 360. Credit to be arranged. *All members of the graduate staff*

COURSES CURRENTLY UNSCHEDULED

219L. Benthic Marine Algae

243S. Classification of Angiosperms

247L. Plant Ecology

260L. Plant Anatomy

263L. Tropical Seaweeds

344. Micrometeorology and Biometeorology Seminar

RELATED PROGRAMS

The University Program in Cell and Molecular Biology. Cell and molecular biology courses offered by the botany department are an integral part of this Interdepartmental Program. Refer to the announcement in this bulletin under Cell and Molecular Biology for descriptions of the following courses: 259. Molecular Biology I—Protein and Membrane Structure/Function and 264. Cell and Molecular Biology Seminar.

The University Program in Genetics. Genetics courses offered by the Botany Department are an integral part of this interdepartmental program. Refer to the announcement in this bulletin under The University Program in Genetics for descriptions of the following courses: 215. Molecular Genetics; 336. Immunogenetics; 350. Genetics Colloquium.

The University Program in Marine Sciences. Interdisciplinary programs emphasizing marine botany are available. Refer to the section on The University Program in Marine Sciences.

Program in Tropical Biology. Fellowships are available for travel and subsistence in field-oriented programs in Central America. Refer to the section on Organization for Tropical Studies in the chapter "Special and Cooperative Programs."

Business Administration

Professor Keller, *Dean* (219W Fuqua School of Business); Professor Bettman, *Director of Graduate Studies* (429E Fuqua School of Business); Professors R. Ashton, Baligh, Burton, Cohen, Forsyth, Laughhunn, Lewin, Morey, Naylor, Payne, Staelin, and Winkler; Associate Professors A. Ashton, Battle, Breeden, Huber, Mazzola, McCann, Magat, Vaupel, and Whaley; Assistant Professors Boulding, Butt, Burke, Daniels, Edell, Foster, Gardner, Lindahl, McCardle, Moore, Nau, Philbrick, Ricks, Romanelli, Sheppard, Stephan, and Tsui

The Ph.D. in Business Administration program prepares candidates for research and teaching careers at leading educational institutions and for careers in business and governmental organizations where advanced research and analytical capabilities are required. The Ph.D. program places major emphasis on independent inquiry, on the development of competence in research methodology, and on the communication of research results.

The program requires that doctoral candidates must acquire expertise in three disciplines: economics, behavioral science, and quantitative methods. In addition, each candidate must acquire knowledge at the M.B.A. level of at least three of the following functional areas: accounting, finance, marketing, and operations management. Competence in the three disciplines and the functional areas may be gained from the student's choice of course work, participation in seminars, and independent study. Each student takes a comprehensive examination at the end of the second year or at the beginning of the third year of residence. The final requirement is the presentation of a dissertation. The Ph.D. program usually requires four years of work beyond the bachelor degree. Students entering the program with an M.B.A. or other advanced work may be able to reduce the time in residence.

Refer to the *Bulletin of Duke University: The Fuqua School of Business* for a complete list of courses and course descriptions.

510. Bayesian Inference and Decision. Methods of Bayesian inference and statistical decision theory, with emphasis on the general approach of modeling inferential and decision-making problems as well as the development of specific procedures for certain classes of problems. Topics include subjective probability, Bayesian inference and prediction, natural-conjugate families of distributions, Bayesian analysis for various processes, Bayesian estimation and hypothesis testing, comparisons with classical methods, decision-making criteria, utility theory, value of information, and sequential decision-making. 3 units. *Winkler*

521. Organization Seminar: A Micro Focus. Individual and small group behavior in organizations. Theories of motivation, decision making, interpersonal behavior, group processes, and leadership. A variety of research approaches and methods includes presentation of behavioral research by members of the Fuqua School of Business and other researchers. 3 units. *Staff*

522. Organization Seminar: A Macro Focus. The organization and the subunits which make up the organization. Theories of organization, structure, decentralization, divisionalization, functional area integration, task design, incentives and rewards, information systems, and decision rules are developed with an orientation toward their choice and design for high performance. Includes presentation of research by members of the Fuqua School of Business and other researchers. 3 units. *Staff*

531. Financial Accounting Seminar. The nature of published financial statement information and its relationship with various economic variables. The list of related variables might include stock market data, bankruptcy filings, and the actions of various users of financial statement information, including management, investors, creditors, and regulators. The focus is on the current research methodologies and research efforts used to analyze the above relationships. A background in masters level accounting and finance is assumed. 3 units. *Staff*

532. Management Accounting Seminar. Information systems and their use in facilitating management decision making and organizational control. Emphasis on the appropriate research methodologies and paradigms including information economics, decision theory, and organizational theory. Topics include budgeting, incentive systems/performance evaluation, variance investigation, and cost allocation. 3 units. *Staff*

551. Corporate Finance Seminar. Introduction to research areas in corporate finance. Emphasis on the research interests of the instructor, and one of the following topics to be explored in depth: capital budgeting, capital structure, mergers and acquisitions, international finance, and cash management. 3 units. *Staff*

552. Investment Seminar. Survey of research in the investment area and exploration in depth of one or more problems in which research is currently active. Emphasis determined by the instructor from one or more of the following areas: valuation of risky securities, capital asset pricing model and extensions, capital market efficiency, portfolio theory, options and warrants, investment management, and futures contracts. 3 units. *Staff*

561. Seminar in Quantitative Research in Marketing. An overview of the quantitative techniques which are important in marketing research. Each model and technique will be examined in considerable detail so as to permit an understanding of its assumptions, structure, and usefulness. Topics covered will include the general data analysis techniques as well as models from advertising, new products, and pricing decisions. 3 units. *Staff*

562. Seminar in Behavioral Models in Marketing. Examines the development of research in consumer behavior. Major emphasis is given to theoretical developments and empirical research. Students are expected to formulate and test a framework or model of consumer behavior with respect to a marketing problem or topic. 3 units. *Staff*

571. Operations Strategy Seminar. Recent developments in the strategy of operations in both the manufacturing and service sectors. Topics include the focused factory concept, Japanese manufacturing philosophy, technological policy toward new process development and toward new product introduction, vertical integration, choice of capacity and location, industry analysis, and the impact of government regulation. Emphasis on the development of hypotheses about strategic topics and the empirical means by which they can be tested. 3 units. *Staff*

572. Seminar in Operational and Technological Tactics. Current issues in the day-to-day management of manufacturing and service delivery systems. Topics include material requirements planning, capacity requirements planning, quality of work life projects, productivity measurement and enhancement, implementation of new product introductions and production process modifications, quality assurance, production planning and scheduling, and logistics. Concentration on the substance of recent developments, the generation and test of hypotheses about tactical issues, and the applicability of various optimization techniques to the advance of operation tactics. 3 units. *Staff*

597. Dissertation Research. For students actively pursuing research on their dissertation. Prerequisites: student must have passed the preliminary examination and have the consent of the Director of the Doctoral Program and instructor. Credit to be arranged. *Staff*

598. Independent Study. Allows the doctoral student the opportunity to engage in study or tutorial on special topics on an individual basis under the supervision of a faculty member. Prerequisites: Doctoral Program standing and consent of the Director of the Doctoral Program and instructor. Credit to be arranged. *Staff*

599. Directed Research. Allows the doctoral student to engage in individual research projects under the supervision of a faculty member. Prerequisites: Doctoral Program standing and consent of the Director of the Doctoral Program and instructor. Credit to be arranged. *Staff*

The University Program in Cell and Molecular Biology

Program Administration: Professor Hill, *Director* (biochemistry); Associate Professor B. Kaufman, *Associate Director* (biochemistry); Professors Erickson (anatomy), Modrich (biochemistry), McClay (zoology), and Pizzo (pathology); Associate Professors Keene (microbiology and immunology), Siedow (botany); Assistant Professor Caron (physiology)

Faculty: A complete list of faculty, including research interests, will be made available to prospective students.

Research training in cell, developmental, and molecular biology is found in eight departments at Duke University: anatomy, biochemistry, botany, microbiology and immunology, pathology, pharmacology, physiology, and zoology. To effectively utilize this broad spectrum of expertise for the training of promising, young scientists while still providing a coherent curriculum, the Duke University Program in Cell and Molecular Biology has been established.

During the first year of doctoral study a student will complete the program's three-course sequence presenting current understanding and research activities in cell biology and the molecular biology of nucleic acids, proteins, and membranes. Each student will also affiliate with a department, fulfill departmental requirements, and choose elective courses in an area of specialization. Research training is stressed throughout the program and dissertation research usually begins by the third semester. Normally the dissertation adviser will be chosen from within the student's own department but, depending on the student's research interests, dissertation research with an adviser in another department may be approved.

Prospective students may apply directly to the Cell and Molecular Biology Program or to one of the eight participating departments. Those who apply to the program must also designate a departmental preference. Applicants must have demonstrated, in addition to overall academic excellence, a proficiency in the biological and physical sciences. Applications for admission and fellowship support must be received by February 1, but early applications may receive advanced consideration.

259. Molecular Biology I: Protein and Membrane Structure/Function. Detailed concepts of the structure and function of proteins as enzymes and as structural elements of cellular substructures, including: protein primary structure and its determination, patterns of protein folding, mechanisms of enzyme catalysis and regulation, function and formation of multimeric protein assemblies, proteins and other constituents of biological membranes. Prerequisite: introductory biochemistry or consent of instructor. C-L: Anatomy 259, Biochemistry 259, and Microbiology and Immunology 259. 3 units. *Richardson and staff*

264. Cell and Molecular Biology Seminar. Required of all students. Third- and fourth-year students discuss their dissertation research. 1 unit. *Staff*

268. Molecular Biology II: Nucleic Acids. Structure and metabolism of nucleic acids in the context of their biological function in information transfer. Prerequisites: introductory biochemistry, Molecular Biology I, or consent of instructor. C-L: Biochemistry 268, Botany 268, and Microbiology and Immunology 268. 4 units. *Modrich and staff*

269. Advanced Cell Biology. Structural and functional organization of cells and their components with emphasis on current research problems and prospects. Prerequisite: introductory cell biology or consent of designated instructor. C-L: Anatomy 269, Botany 269, Microbiology and Immunology 269, and Zoology 269. 3 units. *McClay and staff*

Chemistry

Professor Lochmüller, *Chairman* (101 Gross Chemical Laboratory); Associate Professor Baldwin, *Director of Graduate Studies* (329 Gross Chemical Laboratory); Professors Arnett, Chesnut, Crumbliss, Fraser-Reid, Jeffs, Krigbaum, McPhail, Palmer, Poirier, Porter, Smith, Strobel, Wells, and Wilder; Associate Professors Henkens and Shaw; Assistant Professors MacPhail and Polniaszek; Professor Emeritus Quin; Adjunct Professors Ghirardelli, Millington, Painter, Pitt, and Spielvogel

In the Department of Chemistry graduate work is offered leading to the M.S. and Ph.D. degrees. Before undertaking a graduate program in chemistry, a student should have taken an undergraduate major in chemistry, along with related work in mathematics and physics.

Graduate courses in the department are offered in the fields of analytical, inorganic, organic, and physical chemistry. Research programs are active in all these fields.

A booklet providing detailed information on the department is available from the Director of Graduate Studies.

For Seniors and Graduates

201. Molecular Spectroscopy. Selected spectroscopic methods in the study of molecular structure. Symmetry and group theoretical basis for selection rules, theories of magnetic and optical resonance, and interpretation of spectra; examples from both inorganic and organic chemistry. Three lectures. Prerequisite: consent of department. 1 to 3 units. *Staff*

203. Quantum Chemistry. Basic principles of quantum and group theoretical methods. Topics include symmetry, a review of the fundamentals, and the mathematical foundations of quantum theory. Emphasis on the application of molecular orbital theory to organic and inorganic systems. Prerequisite: Chemistry 162. 1 to 3 units. *Chesnut*

205. Structure and Reaction Dynamics. Structure and mechanisms in organic and inorganic compounds, substitution reactions, linear free energy relations, and molecular rearrangements. Emphasis on the use of kinetic techniques to solve problems in reaction mechanisms. Three lectures. Prerequisite: consent of department. 1 to 3 units. *Staff*

207. Principles of Kinetics, Thermodynamics, and Diffraction. Three lectures. Prerequisite: consent of instructor. 1 to 3 units. *Staff*

275, 276. Advanced Studies. (1) Analytical chemistry, (2) inorganic chemistry, (3) organic chemistry, and (4) physical chemistry. Open to especially well-prepared undergraduates by consent of department. 6 units. *Staff*

For Graduates

300. Basic Statistical Mechanics. Fundamentals of quantum and classical statistical mechanics using the ensemble approach. Emphasis on systems of weakly interacting particles with internal degrees of freedom. 3 units. *Staff*

302. Basic Quantum Mechanics. The fundamentals of quantum mechanics with special emphasis on chemical applications. Topics included are: linear algebra, the uncertainty relations, angular momentum, perturbation theory and time dependent phenomena, molecules in electromagnetic fields, group methods, and electron correlation. 3 units. *Staff*

303, 304. Special Topics in Physical Chemistry. Presentation of one or more topics of staff interest such as advanced methods in crystallography, light scattering and small angle X-ray diffraction, application of ESR spectroscopy to chemical problems, electronic spectroscopy of proteins, group theory, intermolecular forces, liquid crystals, methods of determining the rates of elementary steps in reaction kinetics, physical chemistry of aerosols, physical-chemical methods of polymer characterization, structure and bonding in metallo-enzymes, statistical mechanics of fluids, topics in structural chemistry, and triplet excitons. 1 to 3 units each. *Staff*

310. Theoretical and Structural Inorganic Chemistry. An advanced study of theoretical concepts and structural determination techniques as applied to inorganic systems. Areas included are crystal field and ligand field theories; magnetic susceptibility; and electronic, infrared, and Raman spectroscopy. 3 units. *Crumbliss and Palmer*

312. Inorganic Reactions and Mechanisms. Chemistry of main group and transition elements. Emphasis on current developments in synthetic and mechanistic studies of inorganic, organometallic, and organometalloid compounds. 3 units. *Crumbliss and Wells*

313. Special Topics in Inorganic Chemistry. Lectures, oral reports, and discussions on advanced topics and recent advances in the field of inorganic chemistry. Examples of topics which may be discussed are bioinorganic chemistry, fluxional molecules, homogeneous catalysis, synthesis and properties of selected groups of compounds, and new physical methods. 1 to 3 units. *Staff*

320. Synthetic Organic Chemistry. A study of the scope and limitations of the more important types of reactions in synthetic organic chemistry. Some discussion of the rapidly developing use of transition metals, complex hydrides, and photochemistry will be included. 3 units. *Baldwin or Sternbach*

322. Organic Reactive Intermediates. A discussion of reactive intermediates in organic chemistry. Topics will include carbanions, carbenes, carbonium ions, free radicals, photochemical excited states, and other reactive species. 3 units. *Arnett, Porter, and Wilder*

324. Special Topics in Organic Chemistry. Advanced topics and recent developments in the field of organic chemistry. Representative topics include heterocyclic chemistry, natural products chemistry, carbohydrate chemistry, molecular mechanics, and 2-dimensional NMR spectroscopy. Lectures and written and oral reports. 1 to 3 units. *Staff*

330. Separation Science and Fundamental Electrochemistry. Section .01, fundamental separation chemistry; section .02, practical aspects of chromatographic separation methods; section .03, fundamentals of electrochemistry. 1 to 3 units. *Staff*

331, 332. Special Topics in Analytical Chemistry. An advanced treatment of important areas in modern analysis. Possible topics include: electrochemistry,

small computer applications, magnetic resonance, and problem-solving approaches. 1 to 3 units each. *Staff*

334. Chemical Instrumentation and Practical Electrochemistry. Section .01, basic chemical instrumentation; section .02, optical chemical instrumentation; section .03, practical electrochemistry. 1 to 3 units. *Staff*

373, 374. Seminar. One unit is required of all Ph.D. candidates in chemistry. One hour a week discussion. 1 unit each. *All members of the graduate staff*

375, 376. Research. The aim of this course is to give instruction in methods used in the investigation of original problems. Individual work and conferences. 1 to 6 units each. *All members of the graduate staff*

377. Research Orientation Seminar. A survey of departmental research. Required of all entering graduate students in chemistry. Prerequisite: consent of Director of Graduate Studies. 1 unit. *All members of the graduate staff*

Classical Studies

Professor Herington, *Chairman* (333 Carr); Associate Professor Younger, *Director of Graduate Studies* (316 Carr); Professors Newton, Oates, and Richardson; Associate Professors Boatwright, Burian, Rigsby, and Stanley; Professor Emeritus Willis; Visiting Professor Michels

The Department of Classical Studies offers graduate work leading to the A.M. and Ph.D. degrees. For regular admission, students should offer three years of college study in one of the classical languages and two college years in the other; courses in ancient history and in classical art and archaeology are strongly recommended. Upon matriculation all students take a diagnostic examination in Greek and Latin to determine the appropriate language and literature courses for further study. A reading knowledge of two modern languages, German and French, is required of all candidates for the Ph.D; the candidate should meet one of the language requirements by the end of the first term in residence and the other by the end of the third term. Before beginning the dissertation, the typical student will have taken at least six courses in Greek, six in Latin, five in history, and two in art and archaeology, and a qualifying examination in both Greek and Latin literature based upon the department's reading list. Students then take the following preliminary examinations: in the general area of concentration (e.g., art and archaeology, Greek and Latin literature, or ancient history), in the student's special area of concentration, and in a subject unrelated to the student's proposed dissertation. The department maintains one of the country's major collections of Greek and Latin manuscripts and papyri, extensive computer facilities in Latin and in Mycenaean, Classical, and modern Greek, and an excellent study collection of Greek and Roman art. The Director of Graduate Studies will provide on request the reading list and a brochure detailing further information about the department's special requirements, dissertation writing, and financial aid; prospective students should also consult the general requirements of the University set forth in the chapter on "Registration" in this bulletin.

GREEK

For Seniors and Graduates

200. Intensive Survey of Greek Literature I. A chronological and thematic history of Greek literature. Readings in representative texts of the major writers, including the early poets and Classical authors. 3 units. *Staff*

201. Intensive Survey of Greek Literature II. A chronological and thematic history of Greek literature. Readings in representative texts of the major Classical and later authors. 3 units. *Staff*

203. Homer. Problems of language and structure in the *Iliad* and the *Odyssey;* present state of Homeric scholarship. 3 units. *Stanley*

222. The Historians. Reading and studies in the major Greek historians Herodotus, Thucydides, and Xenophon. 3 units. *Herington or Rigsby*

For Graduates

301. Seminar in Greek Literature I. Selected authors and topics. 3 units. *Burian, Herington, or Stanley*

302. Seminar in Greek Literature II. Selected authors and topics. 3 units. *Burian, Herington, or Stanley*

399. Directed Reading and Research. Credit to be arranged. *Staff*

Courses Currently Unscheduled

205. Greek Lyric Poets

207. The Dramatists

221. Early Greek Prose

226. The Orators

313. Proseminar in Greek Epigraphy

321. Seminar in Literary Papyri

LATIN

For Seniors and Graduates

200. Intensive Survey of Latin Literature I. A chronological and thematic history of Latin literature. Readings in representative texts of the major Republican authors. 3 units. *Staff*

201. Intensive Survey of Latin Literature II. A chronological and thematic history of Latin literature. Readings in representative texts of the major authors of the late Republic and Empire. 3 units. *Staff*

205. The Roman Novel. Readings in Petronius and Apuleius. 3 units. *Richardson*

206. Cicero. 3 units. *Richardson*

214. The Historians. Readings in representative historical writing chosen from Caesar, Sallust, Livy, and Tacitus. 3 units. *Boatwright or Richardson*

For Graduates

301. Seminar in Latin Literature I. Selected authors and topics. 3 units. *Boatwright, Newton, or Richardson*

302. Seminar in Latin Literature II. Selected authors and topics. 3 units. *Boatwright, Newton, or Richardson*

399. Directed Reading and Research. Credit to be arranged. *Staff*

Courses Currently Unscheduled

204. Epic of the Silver Age: Lucan to Statius

207. Vergil's *Aeneid*

208. Lyric and Occasional Poetry

211. Elegiac Poets

221. Medieval Latin

312. Proseminar in Latin Palaeography

314. Proseminar in Latin Epigraphy

315. Proseminar in Roman Law

CLASSICAL STUDIES (ANCIENT HISTORY)

For Seniors and Graduates

221. Archaic Greece. Greece and the Near East from the Dark Ages to the Persian Wars. C-L: History 259. 3 units. *Oates or Rigsby*

226. Late Antiquity. The institutional, intellectual, religious, and social transformation of the Roman Empire into the Middle Ages. C-L: History 266. 3 units. *Rigsby*

258. Social and Cultural History of the Graeco-Roman World. 3 units. *Oates*

For Graduates

321. Seminar in Ancient History I. Selected topics. 3 units. *Oates or Rigsby*

322. Seminar in Ancient History II. Selected topics. 3 units. *Oates or Rigsby*

399. Directed Reading and Research. Credit to be arranged. *Staff*

Courses Currently Unscheduled

222. Fifth and Fourth Century Greece

223. Alexander and the Hellenistic World

224. The Roman Republic

225. The Roman Empire

327. Seminar in Byzantine History

CLASSICAL STUDIES (ARCHAEOLOGY)

For Seniors and Graduates

231S. Greek Sculpture. Techniques and styles of the major schools and personalities in archaic, classical, and Hellenistic free-standing and architectural sculpture. 3 units. *Stanley or Younger*

232S. Greek Painting. C-L: Art 220S. 3 units. *Stanley*

For Graduates

311. Archaeology Seminar I. Selected topics. 3 units. *Staff*

312. Archaeology Seminar II. Selected topics. 3 units. *Staff*

399. Directed Reading and Research. Credit to be arranged. *Staff*

Courses Currently Unscheduled

233S. Greek Architecture

234S. Roman Sculpture

235S. Roman Architecture

236S. Roman Painting

Under the terms of a cooperative agreement, graduate students of Duke University may take any graduate course offered by the Department of Classics of the University of North Carolina. A list of these courses will be sent upon request.

Computer Science

Professor Rose, *Chairman* (206 North); Assistant Professor Szyld, *Director of Graduate Studies* (102 North); Professors Biermann, Gallie, Loveland, Marinos, Patrick, Reif, A. Rosenberg, Starmer, Trivedi, Utku, and Woodbury; Associate Professors Ballard, C. Ellis, Greenside, Kedem, and Wagner; Assistant Professors Board, Dugan, Gardner, Holliday, and Nadathur; Research Associate Professors J. Ellis, Kootsey, and Ramm; Research Assistant Professors Bein and J. Rosenberg; Adjunct Professor Voight; Adjunct Associate Professor W. Coughran; Adjunct Assistant Professors McHugh and Presotto

The Department of Computer Science offers programs leading to the M.S. and Ph.D. degrees. The department also actively cooperates with the Computer Science Department of the University of North Carolina at Chapel Hill.

A student entering graduate work in computer science should have had three semesters of calculus and one semester of linear algebra, and have a knowledge of data structures, and of assembler as well as higher-level computer programming languages. Research interests of present faculty include mathematical foundations of computer science, artificial intelligence, analysis of algorithms, programming methodology, real-time computing, operating data base systems, computer systems design and analysis, parallel processing systems, scientific computation (including numerical analysis), and very large-scale integration.

Each student should consult the document, *Graduate Degree Requirements of the Computer Science Department*, for degree requirements not listed in this bulletin.

For Seniors and Graduates

200. Programming Methodology I. Practical and theoretical topics including structured programming, specification and documentation of programs, debugging and testing strategies, choice and effective use of programming languages and systems, psychology of computer programming, proof of correctness of programs, analysis of algorithms, and properties of program schemata. Prerequisite: Computer Science 152. 3 units. *J. Rosenberg or Wagner*

201. Programming Languages. Information binding, data structures and storage, control structures, recursion, execution environments, input/output; syntax and semantics of languages; study of PL/1, Fortran, Algol, APL, LISP, SNOBOL, and SIMULA; exercises in programming. Prerequisite: Computer Science 200. 3 units. *Ballard, Holliday, or taught at UNC-CH as Comp 244*

202. Applied Discrete Structures. Aspects of discrete mathematics that are essential to the development of computer science. Topics from combinatorics and graph theory, discrete probability theory, and mathematical logic. Prerequisites: Mathematics 103 and 104 or equivalents. 3 units. *Staff*

204. Computer Network Architecture. See C-L: Electrical Engineering 204. Prerequisite: Electrical Engineering 157. 3 units. *Pitt*

207. Fault-Tolerant Computer Systems. C-L: Electrical Engineering 207. 3 units. *Marinos*

208. Digital Computer Design. C-L: Electrical Engineering 208. 3 units. *Marinos*

209. Microprocessor Fundamentals and Applications. C-L: Electrical Engineering 209. 4 units. *Carroll, George, or Marinos*

210. VLSI Systems: An Introduction. A first course in VLSI using the Mead-Conway approach. Topics include (1) the basic components of MOS technology: the transistor and gates constructed therefrom; (2) techniques for composing components into useful logic blocks: array logic, passive logic networks, sequential machines; (3) introduction to techniques for composing logic blocks into systems; and (4) introduction to software systems that aid the design process. Students will complete the design of a small system in NMOS. Prerequisite: Computer Science 157 or equivalent. 3 units. *Staff or taught at UNC-CH as Comp 268*

215. Artificial Intelligence. Heuristic versus algorithmic methods; programming of games such as chess; theorem proving and its relation to correctness of programs; readings in simulation of cognitive processes, problem solving, semantic memory, analogy, adaptive learning. Prerequisite: Computer Science 152 or consent of instructor. 3 units. *Ballard, Biermann, or Nadathur*

221. Numerical Analysis I. Error analysis, interpolation and spline approximation, numerical differentiation and integration, solutions of linear systems, nonlinear equations, and ordinary differential equations. Prerequisites: knowledge of an algorithmic programming language and intermediate calculus. C-L: Mathematics 221. 3 units. *Gardner, Rose, or Szyld*

222. Numerical Analysis II. Calculation of eigenvalues and eigenvectors, numerical methods for solving partial differential equations, and integral equations. Prerequisite: Computer Science 221 or equivalent. C-L: Mathematics 222. 3 units. *Gardner, Rose, or Szyld*

224. Analysis of Algorithms. Design and analysis of efficient algorithms. Design techniques include recursion, divide-and-conquer, and dynamic programming. Applications include sorting, searching, dynamic structures, pathfinding, fast multiplication, fast Fourier transform. Nondeterministic algorithms. Computationally hard problems. NP-completeness. Prerequisites: Computer Science 152 and four semesters of college mathematics. 3 units. *Loveland, Reif, or A. Rosenberg*

225. Formal Languages and Theory of Computation. An introduction to the study of abstract machines and the languages they define, their capabilities and limitations. Finite-state automata, regular languages, pushdown automata, context-free languages, Turing machines, recursive functions and recursively enumerable sets, noncomputable sets, measures of complexity for algorithms. Prerequisites: four semesters of undergraduate mathematics. 3 units. *Loveland, Reif, or A. Rosenberg*

226. Mathematical Methods for Systems Analysis I. Basic concepts and techniques used in the stochastic modeling of systems. Elements of probability, statistics, queuing theory, and simulation. Prerequisites: four semesters of college mathematics. 3 units. *Trivedi*

227. Mathematical Methods for Systems Analysis II. Basic concepts and techniques used in the deterministic modeling of systems. Elements of linear algebra; linear, integer, dynamic, and geometric programming; and unconstrained and constrained optimization. Prerequisites: four semesters of college mathematics. 3 units. *Staff*

231. Introduction to Operating Systems. Basic concepts and principles of multiprogrammed operating systems. Memory, CPU, I/O device management, and scheduling. Buffering techniques. Performance evaluation. Case studies of

existing systems. Prerequisite: Computer Science 154. 3 units.. *Dugan, Holliday, Trivedi, or taught at UNC-CH as Comp 242*

232. Compiler Construction. Models and techniques used in the design and implementation of assemblers, interpreters, and compilers. Lexical analysis, compilation of arithmetic expressions and simple statements, specifications of syntax, algorithms for syntactic analysis, code generation, and optimization techniques. 3 units. *Wagner*

241. Data Base Methodology. Basic concepts and principles. Relational, hierarchical, and network approaches to data organization; data entry and query language support for data base systems; theories of data organization; security and privacy issues. Prerequisites: Computer Science 154 and either 155 or 163. C-L: Mechanical Engineering and Materials Science 242. 3 units. *McHugh or Starmer*

252. Computer Systems Organization. Hardware and software aspects. Processor, memory, device, and communication subsystems; case studies of hardware system organization, e.g., parallel, associative, fault-tolerant; organization of software systems to exploit hardware systems organization; economic and reliability aspects of various hardware organizations. Prerequisites: Computer Science 154 and 157. C-L: Electrical Engineering 252. 3 units. *Patrick*

265. Advanced Topics in Computer Science. 3 units. *Staff*

276. Communication, Computation, and Memory in Biological Systems. Communication and memory in biological systems: in voltage sensitive ion channels, hormone-receptor interactions, and initiation and control of RNA/DNA synthesis. Models of signaling and memory are developed and related to electronic signaling schemes. Prerequisites: Computer Science 152, two semesters of college chemistry and four semesters of college mathematics. 3 units. *Starmer*

For Graduates

308. Advanced Topics in Digital Systems. C-L: Electrical Engineering 308. 3 units. *Marinos*

310. CMOS VLSI Design. A second course in VLSI, aimed at the design of VLSI systems in CMOS. The main thrusts of the course will be (1) to provide enough background in the theory of CMOS circuits to understand circuit level trade-offs; (2) to introduce a symbolic design system and its supporting software, which greatly aid the design process; (3) to examine sample chip designs with an eye to understanding competitive design methodologies. Students will complete a CMOS-oriented project comprising the design and implementation of either a hardware or a software subsystem. Prerequisite: Computer Science 210 or equivalent. C-L: Electrical Engineering 310. 3 units. *Kedem*

315. Advanced Topics in Artificial Intelligence. Course content will vary from year to year and will include a detailed study of one or more of the following: mechanical theorem proving, natural language processing, automatic program synthesis, machine learning and inference, representations of knowledge, languages for artificial intelligence research, artificial sensorimotor systems, and others. Prerequisite: Computer Science 215. 3 units. *Ballard, Biermann, Loveland, or Nadathur*

316. Computational Linguistics. A historical and technical introduction to the computer processing of English or other natural language inputs, with emphasis on such applications as data base query, programming, and office automation. Topics will include techniques for the morphological, syntactic, semantic, and pragmatic analysis of English. Recent developments in the area will also be studied.

Students will write a short paper and/or do a project. Prerequisite: Computer Science 215. 3 units. *Ballard or Biermann*

320. VLSI Algorithmics. Algorithmic and systems aspects of VLSI. Topics include theoretical studies of the layout problem, array logic, placement and routing, fault-tolerance in VLSI designs, design for testability, the design of networks of processors, and cost trade-offs in VLSI designs. Each student will complete an in-depth study of a topic approved by the instructor. Prerequisites: Computer Science 224 and either 210 or 310. 3 units. *A. Rosenberg*

321. Topics in Numerical Mathematics. Advanced topics in numerical mathematics to be selected from areas of current research. Prerequisites: Computer Science 221 and 222. 3 units. *Gardner, Greenside, Rose, or Szyld*

326. Systems Modeling. Advanced study of analytical models of systems; queuing model and its parameterization and validation. Methods for computer solutions of some models. Prerequisites: Computer Science 226 and 231. 3 units. *Trivedi*

331. Operating Systems Theory. Advanced study of theoretical aspects of operating systems emphasizing models and control of concurrent processes, processor scheduling, and memory management. Prerequisites: Computer Science 226 and 231. 3 units. *Trivedi or Wagner*

382. Seminar in Artificial Intelligence. Topics in artificial intelligence, such as natural language understanding, learning, theorem proving and problem solving, search methodologies. Topics will vary from semester to semester. Includes research literature reading with student presentation. 1-3 units. *Staff*

COURSES CURRENTLY UNSCHEDULED

301. Topics in Programming Theory

325. Theory of Computation

332. Topics in Operating Systems

SUPPLEMENTARY COURSES OFFERED AT UNC-CH

Comp 145. Software Engineering Laboratory

Comp 171. Natural Language Processing

Comp 230. File Management Systems

Comp 236. Computer Graphics

Comp 238. Raster Graphics

Comp 254. Picture Processing and Pattern Recognition

Comp 265. Architecture of Computers

Economics

Professor Weintraub, *Chairman* (215A Social Science); Professor Grabowski, *Director of Graduate Studies* (318 Social Science); Professors Clotfelter, Coats, Cook, Davies, de Marchi, Geweke, Gillis, Goodwin, Graham, Havrilesky, Henderson, Kelley, Kimbrough, Krueger, Lewis, McElroy, Naylor, Tower, Treml, Vernon, Wallace, and Yohe; Associate Professor Tauchen; Assistant Professors Baumgardner, Brock, Marshall, Meurer, Shetty, Stahl, and Zarkin; Adjunct Professors Gallant and Ladd

The Department of Economics offers graduate work leading to the A.M. and Ph.D. degrees. Among the undergraduate courses of distinct advantage to the graduate student in economics are statistics, economic theory, and basic courses

in philosophy, mathematics, and social sciences other than economics. Advanced work in mathematics or statistics is also useful.

Requirements for the Ph.D. degree in economics include courses in economic theory, quantitative methods, and econometrics in the first year, and at the end of the second year, an examination in economic analysis. In addition, a student must obtain certification in three fields, one of which may be in an outside minor. The student may select from advanced economic theory, history of political economy, economic development, economic history, international economics, money and banking, labor economics, public finance, industrial organization, econometrics, statistics, Soviet economics, corporate economics, and certain fields outside the economics department (e.g., demography). Course work for the Ph.D. degree should be completed in five semesters of residence.

For Seniors and Graduates

200. Capitalism and Socialism. Selected ideological classics of new and old, right and left economics including both "counsels for perfection" (utopias) and "precepts for action" in political economy. Prerequisites: Economics 149 and 154 or consent of instructor. 3 units. *Staff*

204S. Advanced Monetary Economics. Monetary theory and its statistical and institutional implementation. Particular attention to the development of aggregative theories of prices, interest rates, and production; the functioning of monetary policy within various theoretical frameworks; appraisal of recent use and limitations of Federal Reserve policy. Prerequisite: Economics 153. 3 units. *Havrilesky or Yohe*

205S. Advanced Monetary Theory and Policy. Emphasis on recent issues: innovations in the payments mechanism and new monetary aggregates, the subterranean economy, financial crises, alternative views of the monetary policy transmission mechanism, and the monetarist-fiscalist controversy. Prerequisite: Economics 138 and 153. 3 units. *Havrilesky or Yohe*

212S. Economic Science and Economic Policy. A historical examination of the impact of economics on public policy; topics vary each semester and have included energy and anti-inflation policy, productivity growth, the Third World, and the Council of Economic Advisers. 3 units. *Goodwin*

213S.1. The Economics of Slavery in the American South. The nature, development, economics and social consequences of slavery in the United States during the nineteenth century. Prerequisites: Economics 149 and consent of instructor. 3 units. *Coats*

214. Social Choice. The economic study of nonmarket decision making. Theory of constitutions, voting rules, voter behavior, the bureaucracy, incentives for reaching consensus, and the evolution of cooperation. Applications to the provision of public goods, and tax policy and redistribution. Available only in the Duke in Amsterdam Summer Program. Prerequisites: Economics 1 or 51, 2 or 52. 3 units. *de Marchi*

214S. Social Choice. A seminar version of 214. Prerequisites: Economics 149 and consent of instructor. 3 units. *de Marchi*

218. Macroeconomic Policy. Does not count for economics major requirements. C-L: Public Policy Studies 218. 3 units. *Luger*

219S. Economic Problems of Underdeveloped Areas. Analysis of underdeveloped countries with some attention to national and international programs designed to accelerate development. Prerequisite: Economics 149 or consent of instructor. 3 units. *Brock or Kelley*

232. Analytical Methods IV: Topics in Economic Policy. Does not count for economics major requirements. C-L: Public Policy Studies 232. 3 units. *Gillis*

233. Federal, State, and Local Finance and Economic Policies. Analysis of expenditures, taxation, debt, public enterprises, and current government programs. Prerequisite: Economics 149 or consent of instructor. 3 units. *Davies*

234. Urban and Regional Economics. Presents models: to analyze metropolitan systems and the location of economic activity; to understand the causes of selected urban and regional problems, including unbalanced growth and development, poor housing conditions, residential segregation, deteriorating services, and fiscal crises; and to assess the impact of public policies toward states and substate areas. Prerequisite: Economics 149 or consent of instructor. 3 units. *Clotfelter or Luger*

239. Introduction to Econometrics. Data collection, estimation, and hypothesis testing. Use of econometric models for analysis and policy. (Not open to students who have had Economics 139.) Prerequisites: Economics 2 or 52 and Mathematics 32 or equivalent and Economics 138 or equivalent. 3 units. *McElroy, Marshall, Tauchen, or Wallace*

243. Econometrics I. Economic theory, mathematics, statistical inference, and electronic computers applied to analysis of economic phenomena. Objective is to give empirical content to economic theory. Matrix algebra used to develop topics in inference, linear regression, and systems of simultaneous equations. Use is made of the electronic computer. Prerequisites: Economics 149 and 237 or equivalents. 3 units. *Marshall, McElroy, Tauchen, or Wallace*

244. Corporate Economics I. Strategic planning models of the firm including marginal analysis, mathematical programming, portfolio, and corporate simulation models. Economics as the language of corporate planning and modeling. Prerequisites: Economics 138 and 149 or equivalents. 3 units. *Naylor*

245. Econometrics II. Advanced theory and applications: includes specification error, generalized least squares, lag structures, Bayesian decision making, simultaneous equation methods, and forecasting. Emphasis on current applied literature. Prerequisite: Economics 243. 3 units. *McElroy, Tauchen, or Wallace*

246. Selected Topics in Econometric Theory. Analysis of panel data, combining data from different sources, vector autoregressive methods, problems of causation in time series data, nonlinear estimation, limited dependent variables, sample selection bias, and other topics to be chosen subject to the interests of the class. 3 units. *Geweke, Tauchen, or Wallace*

247S. Applied Econometrics. Application of current developments in econometric methodology to empirical problems in economics. Emphasis on the conduct of empirical research, including model and hypothesis formulation, testing, and integration of economic and econometric theory. 3 units. *Geweke, Marshall, McElroy, Tauchen, and Wallace*

249. Microeconomics. Cost and supply considerations in price theory; the demand for factors of production. The allocation of resources in the context of competitive and monopolistic market structures. Prerequisites: Economics 2 or 52 and Mathematics 31. (Not open to students who have taken Economics 149.) 3 units. *Staff*

250S. Modern Economic Thought. Integrated survey of the several major streams of economic theory since 1936. Selected topics from the economics of Keynes, its offshoots and coordinate developments, and post-Marxian economic theory. Historical evolution of recent ideas and their interrelations. Prerequisite: Economics 138 and 149 and 154 or consent of instructor. 3 units. *de Marchi or Weintraub*

254. Macroeconomics. Concepts and measurement of national income and expenditures, employment interest rates, and price levels; the theoretical determination of these aggregates, applications of macroeconomic growth. (Not open to students who have taken Economics 154.) 3 credits. *Staff*

265S. International Trade and Finance. Fundamental principles of international economic relations. The economic basis for international specialization and trade and the economic gains from trade, the balance of international payments, problems of international finance, investments, and monetary problems. Prerequisites: Economics 149 and 154. 3 units. *Brock, Kimbrough, or Tower*

268. Federal Tax Policy. Does not count for economics major requirements. C-L: Public Policy Studies 268 and Law 518. 3 units. *Clotfelter or Schmalbeck*

286S. Economic Policy Making in Developing Countries. Does not count for economics major requirements. C-L: Public Policy Studies 286S. 3 units. *Gillis*

293. Soviet Economic History. Establishment of foundations of a socialist economy: collectivization, industrialization, and search for economic efficiency. 3 units. *Treml*

294S. Soviet Economic System. Economic planning and administration in the Soviet Union and other socialist countries. International comparisons. Theoretical and applied problems of resource allocation, economic development, and optimal micro decision-making in a nonmarket economy. 3 units. *Treml*

For Graduates

301. Microeconomic Analysis I. Review of contemporary theory relating to production, the firm, and income distribution in competitive and imperfectly competitive markets. 3 units. *Graham*

302. Microeconomic Analysis II. A continuation of Economics 301 with emphasis on analyses of consumer behavior, general equilibrium, welfare economics, and capital theory. Prerequisite: Economics 301. 3 units. *Staff*

304, 305. Monetary Theory and Policy. 304: theories of the supply of and demand for money (neoclassical and Keynesian macroeconomic), general equilibrium theories, and theories of the term structure of interest rates. 305: the theory and practice of monetary policy with emphasis on recent issues, the monetarist-fiscalist controversy, the monetary policy transmission mechanism, and policy simulations with econometric models. 3 units each. *Havrilesky, Kimbrough, or Yohe*

307. Quantitative Analysis I. A systematic analysis of the principal quantitative methods used in microeconomic theory. Neoclassical theories of production and distribution are used as vehicles for presenting the material. Considerable emphasis is placed on the application of mathematical analysis to economic models. 3 units. *Weintraub*

308. Quantitative Analysis II. Dynamic optimization techniques, including the calculus of variations and optimal control, are analyzed and applied to problems involving capital accumulation, resource extraction, and aspects of firm behavior. 3 units. *Graham, Henderson, or Stahl*

311, 312. History of Political Economy. A detailed review of the development of economic theory, the tools of economic analysis, and economics as a science, together with an analysis of the circumstances affecting this development. Period covered: pre-Christian times through 1936. 3 units each. *Goodwin*

313, 314. Seminar in Economic Theory. Prerequisite: Economics 301 or equivalent. 3 units each. *Weintraub*

317. Seminar in Demographic, Population, and Resource Problems (Development Economics I). Historical, empirical, and theoretical topics in development economics focusing on real aspects of growth in a closed economy. Special attention to human resource economics (demography, education, nutrition), models of dualism, agricultural growth, and technology. 3 units. *Brock or Kelley*

319. Seminar in the Theory and the Problems of ·Economic Growth and Change (Development Economics II). Links between aid, financial markets, and real investment in an open economy stressing tariff protection and capital controls (internal and external). Economic policy making using market solutions and/or planning models (input-output, linear programming, and computable general equilibrium). 3 units. *Brock*

320. Macroeconomic Analysis I. Measurement of national income and other important aggregates; classical macroeconomics; Keynesian and more recent views of the determinants of income, employment, and price levels; empirical studies of consumption, investment, and monetary variables. 3 units. *Geweke or Kimbrough*

322. Macroeconomic Analysis II. Further analysis of topics treated in Economics 320. Optimal economic growth; business cycles. Issues in economic policy. Prerequisite: Economics 320. 3 units. *Geweke or Tauchen*

323. Income Distribution Theory. Functional and personal income distributions. Concepts and measures of poverty and inequality. Ethical and economic maldistribution issues. Pricing of productive services, primary attention on wages and employment. Rival aggregative (macrodistribution) theories. Prerequisites: intermediate micro- and macroeconomics and some knowledge of calculus and statistics. 3 units. *Staff*

324, 325. Economics of the Law. An introduction to the methods of economic analysis with applications to legal issues. An elementary exposition of the mathematics of constrained optimization is included. Prerequisite for Economics 325: 324. 3 units each. *Graham*

329. Federal Finance. An analysis of the trends and hypotheses concerning the growth in governmental activity, the optimum level and composition of governmental spending, and the microeconomic and macroeconomic effects of governmental spending and tax policies. 3 units. *Clotfelter, R. Conrad, or Davies*

330. Seminar in Public Finance. 3 units. *Staff*

350. Modern Economic Thought. Principles of microeconomics in the analysis of problems and policies. The particular contextual materials that will be subjected to analysis will vary. Materials will be treated in the tradition of positive economics. 3 or 6 units. *Staff*

355. Seminar in Labor Economics. 3 units. *McElroy or Zarkin*

358. Seminar in Labor Market and Related Analysis. 3 units. *McElroy or Zarkin*

359. Economic Analysis of Legal Issues. An exploration of diverse topics in law and economics such as property rights and externalities, tort law and optimal accident prevention, bargaining and game theory, the economics of contracts, and theories of economic justice. C-L: Law 359. 3 units. *Culp*

365. Seminar in International Trade Theory and Policy. 3 units. *Tower*

366. Seminar in International Monetary Theory. 3 units. *Kimbrough*

380. Graduate Economics Workshops. For postpreliminary students. May be taken for multiple credit. Sections: 01. Industrial Organization and Regulation; 02. International Economics; 03. Labor Economics; 04. Macroeconomics; 05. Public

Finance; 06. Economic Thought; 07. Corporate Economics; 08. Applied Econometrics. 3 units each. *Staff*

388. Industrial Organization. The theory, measurement, and history of the firm-structure of industry. Emphasis upon the structure of American industry and upon actual production and pricing practices. Criteria for evaluating industrial performance. 3 units. *Grabowski or Vernon*

389. Seminar in Industrial and Governmental Problems. 3 units. *Grabowski or Vernon*

397, 398. Directed Research. 3 units. *Staff*

COURSES CURRENTLY UNSCHEDULED

235. The Economics of Crime, Law Enforcement, and Justice

285. Evaluation of Public Expenditures

303. Theory of Economic Decision Making

316. Seminar in Economics of Soviet-Type Socialism

321. Theory of Quantitative Economic Policy

331. Seminar in Economic History

345, 346. Demographic Techniques I and II

401. Seminar on the British Commonwealth

402. Interdisciplinary Seminar in the History of the Social Sciences

RELATED COURSES IN OTHER DEPARTMENTS

Courses in related fields may be selected from anthropology, computer science, forestry, history, mathematics, philosophy, political science, public policy sciences, and sociology, or from an area that complements the candidate's area of research interests in economics.

See the Center for Demographic Studies in the chapter "Special and Cooperative Programs" for further information.

Education

Associate Professor Davis, *Chairman* and *Director of Graduate Studies* (213 West Duke); Professor Page; Associate Professors Ballantyne, Carbone, Di Bona, Johnson, and Sawyer; Professor Emeritus Gehman; Adjunct Associate Professor Pittillo; Lecturer Fowler

For students admitted to graduate programs prior to fall 1981, specific requirements may be obtained in the Graduate School office. Qualified juniors, seniors, and graduate students may enroll in appropriate education courses as electives.

For Seniors and Graduates

205, 206. Selected Topics. Three units each. *Staff*

211. Education and the Mass Media. Impact of mass media on behavior, particularly of children. 3 units. *Di Bona*

212S. Pedagogy and Political Economy: A World View. The relationships of employment, schooling, and government policy. Concepts of social class, ideology, and hegemony used to analyze past and present developments. Selected national systems, (such as those of Japan, India, and the U.S.S.R.) compared to American educational practices from Marxist and liberal perspectives. One course. *Di Bona*

215S. Seminar in Secondary School Teaching. Principles, practices, and problems in secondary school instruction. 3 units. *Carbone or staff*

216. Secondary Education: Internship. Supervised internship in senior high schools, involving some full-time teaching. Prerequisites: C average overall and in teaching field or fields; for student teachers only. 6 units. *Carbone or staff*

225. The Teaching of History and the Social Studies. Evaluation of the objectives, content, materials, and methods in the teaching of history and the social studies. 3 units. *Carbone and staff*

232. Psychoeducational Counseling with Families. Individual and group counseling concerning psychoeducational problems of families. Prerequisite: consent of instructor. 3 units. *Ballantyne and Davis*

236. Teaching Developmental and Remedial Reading in the Secondary School. Principles, methods, and materials for the development of effective reading attitudes and skills in developmental and remedial programs. 3 units. *Staff*

242. Group Counseling. Theories and techniques of counseling for small groups of children, adolescents, teachers, parents, and other adults. Prerequisite: consent of instructor. 3 units. *Ballantyne*

246. Teaching of Mathematics. Aims, curriculum, and classroom procedure for teaching secondary school mathematics. 3 units. *Staff*

276. Teaching of High School Science. Discussion, lectures, and collateral reading related to such topics as aims, tests, curriculum, classroom and laboratory procedure, field trips, and course and lesson planning for secondary school science. 3 units. *Staff*

For Graduates

350, 351. Directed Activities in Education. Internship experiences at an advanced level under supervision of appropriate staff. Prerequisite: consent of instructor. 3 units each. *Staff*

357. Directed Research. For students who have passed the preliminary examination. 1 to 6 units. *Staff*

COURSES CURRENTLY UNSCHEDULED

227. Contemporary Theories of Counseling and Psychotherapy

248. Practicum in Counseling

Engineering

Earl H. Dowell, Sc.D., *Dean* (305 Teer Engineering Library Building)

The School of Engineering offers programs of study and research leading to the M.S. and Ph.D. degrees with a major in biomedical, civil and environmental, electrical engineering, or in mechanical engineering and materials science. These programs are designed to provide a fundamental understanding of the engineering sciences, which are based on mathematics and the physical sciences, and to develop experience in the art of engineering, which includes strong elements of intuition, imagination, and judgment. Engineering graduate students may participate in seminars appropriate to their fields of study.

A *minimum* of 30 units of earned graduate credit beyond the bachelor's degree is required for the M.S. degree: 12 in the major, 6 in related minor work (usually mathematics or natural science), 6 in either the major or minor subject or in other areas approved by the major department, and 6 for a research-based thesis. A

nonthesis option requiring 30 units of course credit is available. Each of the departments imposes additional requirements in the exercise of this option. There is no language requirement for this degree.

A *minimum* of 60 units of earned graduate credit beyond the bachelor's degree is required for the Ph.D. degree. In civil and environmental engineering, 12 units of course work beyond the Master's degree are required to be in the major field, 6 in a related minor field, and 6 in either the major or minor field; in electrical engineering, 24 units are required in the major field and 12 units in a related minor field (often mathematics or natural science), 12 in either the major or minor subject or other areas approved by the major department, and 12 for a research-based dissertation. In biomedical and mechanical engineering there are no specific course requirements; each program is planned to meet individual needs. Doctoral students are required to pass qualifying and preliminary examinations which may be either written, oral, or a combination of written and oral components, at the discretion of the committee and the department.

BIOMEDICAL ENGINEERING

Professor McElhaney, *Chairman* (136 Engineering); Professor Plonsey, *Director of Graduate Studies* (276 Engineering Annex); Professors Clark, Hammond, Hochmuth, Nolte, Pilkington, Plonsey, Thurstone, von Ramm, and Wolbarsht; Associate Professors Burdick, Jaszczak, and Riederer; Assistant Professors Daniels, Miller, Nandedkar, and Trahey

Biomedical Engineering is the discipline in which the physical, mathematical, and engineering sciences and associated technology are applied to biology and medicine. Contributions range from modeling and simulation of physiological systems through experimental research to solutions of practical clinical problems. The goal of the graduate program in biomedical engineering is to combine training in advanced engineering, biomedical engineering, and the life sciences so that graduates of the program can contribute at the most advanced professional level. The doctoral dissertation should demonstrate significant and original contributions to an interdisciplinary topic, accomplished as an independent investigator. The major, current, research areas are: biomechanics, biomedical materials, biomedical modeling, data acquisition and processing, medical imaging, and electrophysiology. Every biomedical engineering graduate student is required to serve as a teaching assistant as part of the graduate training.

201. Electrophysiology. The electrophysiology of excitable cells from a quantitative perspective. Topics include the ionic basis of action potentials, the Hodgkin-Huxley model, impulse propagation, source-field relationships, and an introduction to functional electrical stimulation. Student chooses a relevant topic area for detailed study and report. Not open to students who have taken Biomedical Engineering 101 or equivalent. 3 units. *Plonsey*

202. Biomedical Transfer Processes. An introduction to biomedical diffusion and momentum transfer with particular emphasis on physical models of biological and artificial organ systems. 3 units. *Clark and Hochmuth*

205, 206. Microprocessors and Digital Instruments. Design of microcomputer-based devices including both hardware and software considerations of system design. Primary emphasis on hardware aspects, including a progression through initial design, prototype construction in the laboratory, testing of prototypes to locate and correct faults, and final design evaluation. Evaluation includes examination of complexity, reliability, and cost. Design and construction oriented toward biomedical devices or instruments that include dedicated microcomputers, usually operating in real time. Prerequisites for 205: Engineering 51 and Biomedical

Engineering 163, 164 or equivalents; for 206: satisfactory work in 205. 4 units each. *Barr, Hammond, and von Ramm*

211. Theoretical Electrophysiology. Mathematical analysis of intracellular and extracellular currents and voltages arising from subthreshold and transthreshold stimuli applied to excitable tissue (cardiac and striated muscle and nerve). Bases for and behavior of models of excitable tissue utilizing discrete and continuous formulations. Evaluation of sources of extracellular fields. Description of, and evaluation of, models of membrane behavior. Laboratory exercises based on computer simulation, with emphasis on quantitative behavior and design. Readings from original literature. Prerequisite: Biomedical Engineering 101 or 201. 4 units. *Barr and Plonsey*

212. Theoretical Electrocardiography. Mathematical analysis of currents flowing between the heart and body surface. Cardiac electrophysiology. Consideration of cardiac models, inhomogeneities, and surface lead systems. Examination of lead systems, and the interpretation of body surface measurements using inverse calculations. Laboratory exercises based on computer simulation with emphasis on quantitative behavior and design. Readings from the original literature. Prerequisite: Biomedical Engineering 101 or 201. 4 units. *Barr and Plonsey*

215. Biomedical Materials and Artificial Organs. Chemical structures, processing methods, evaluation procedures, and regulations for materials used in biomedical applications. Applications will include implant materials, components of *ex vivo* circuits, and cosmetic prostheses. Primary emphasis will be placed on polymer-based materials and on optimization of parameters of materials which determine their utility in applications such as artificial kidney membranes and artificial arteries. Prerequisite: Engineering 83 or Chemistry 151 or consent of instructor. C-L: Mechanical Engineering 215. 3 units. *Clark*

222. Principles of Ultrasound Imaging. Propagation, reflection, refraction, and diffraction of acoustic waves in biologic media. Topics include geometric optics, physical optics, attenuation, and image quality parameters such as signal-to-noise ratio, dynamic range, and resolution. Emphasis is placed on the design and analysis of medical ultrasound imaging systems. Prerequisites: Physics 52 and Mathematics 111. 3 units. *von Ramm*

230. Biomechanics. Basic elements of mechanics are developed with application in biomechanics. Primary emphasis is given to trauma mechanisms, injury criteria, and human protection. Head and neck injuries and helmet design are discussed. Case studies from product liability lawsuits with a strong biomechanics context are discussed in a seminar mode. 3 units. *McElhaney*

233. Modern Diagnostic Imaging Systems. The underlying concepts and instrumentation of several modern medical imaging modalities. Review of applicable linear systems theory and relevant principles of physics. Modalities studied include X-ray radiography (conventional film-screen imaging and modern electronic imaging), computerized tomography (including the theory of reconstruction), and nuclear magnetic resonance imaging. Prerequisite: consent of instructor. 3 units. *Riederer*

235. Acoustics and Hearing. This course covers the generation and propagation of acoustic (vibrational) waves and their reception and interpretation by the auditory system. Topics under the heading of generation and propagation include free and forced vibrations of discrete and continuous systems, resonance and damping, and the wave equation and solutions. To understand the reception and interpretation of sound, the anatomy and physiology of the mammalian auditory system are presented, and the mechanics of the middle and inner ears studied. Prerequisites: Physics 52 and Mathematics 111 or equivalents. 3 units. *Miller*

265. Advanced Topics in Biomedical Engineering. Advanced subjects related to programs within biomedical engineering tailored to fit the requirements of a small group. Prerequisites: consent of Chairman and instructor. 1 to 4 units. *Staff*

For Graduates

333. Biomedical Imaging. A study of the fundamentals of information detection, processing, and presentation associated with imaging in biology and medicine. Analysis of coherent and incoherent radiation and various image generation techniques. Also covered will be the psychometrics of image evaluation dealing with subjective and objective parameters. Emphasis will be placed upon sonography, thermography, X-ray, various forms of nuclear radiography, microscopy, and holography. 3 units. *Thurstone*

399. Special Readings in Biomedical Engineering. Individual readings in advanced study and research areas of biomedical engineering. Prerequisite: approval of Director of Graduate Studies. 1 to 3 units each. *Staff*

COURSES CURRENTLY UNSCHEDULED

204. Measurement and Control of Cardiac Electrical Events

207. Experimental Mechanics

221. Electrophysiological Techniques

243. Computers in Biomedical Engineering

311. Inverse Models

CIVIL AND ENVIRONMENTAL ENGINEERING

Professor Vesilind, *Chairman* (121 Engineering); Professor Melosh, *Director of Graduate Studies* (134 Engineering); Professors Muga, Utku, Vesilind, and J. F. Wilson; Associate Professors Biswas, Bryers, Medina, Pas, Peirce, Petroski, and Reckhow; Assistant Professor Marin; Adjunct Professor Kranich

A student may specialize in one of the following fields of study for either the M.S. or the Ph.D. degree: environmental engineering; geotechnical engineering and soil mechanics; mechanics of solids; materials engineering; fluid mechanics, water resources, and ocean engineering; structural engineering; and urban systems and transportation. Interdisciplinary programs combining study in some of the major areas with biological sciences, business administration, materials science, social sciences, political science, public policy studies, and other areas of engineering are also available.

With the approval of the department, a master's degree candidate in civil engineering may choose, in lieu of submitting a thesis, to complete an additional 6 units of course work plus a special project. If this alternative is elected, candidates are expected to take comprehensive examinations over their graduate course work, and also to defend orally their special projects.

Under the Reciprocal Agreement with Neighboring Universities, a student may include as a portion of the minimum requirements work offered by the Department of Environmental Sciences and Engineering of the University of North Carolina. Although related work normally is taken in the natural sciences or mathematics, a student whose major interest relates to the social or managerial sciences may take relevant work in these areas.

201. Advanced Mechanics of Solids. Tensor fields and index notation. Analysis of states of stress and strain. Conservation laws and field equations. Constitutive equations for elastic, viscoelastic, and elastic-plastic solids. Formulation and solution of simple problems in elasticity, viscoelasticity, and plasticity. 3 units. *Petroski*

204. Plates and Shells. Differential equation and extremum formulations of linear equilibrium problems of Kirchhoffian and non-Kirchhoffian plates of isotropic and orthotropic material. Solution methods. Differential equation formulation of thin shell problems in curvilinear coordinates; membrane and bending theories; specialization for shallow shells, shells of revolution, and plates. Extremum formulation of shell problems. Solution methods. Prerequisites: Mathematics 111 and Engineering 75 or 135. 3 units. *Utku*

205. Elasticity. Introduction to linear theory of elasticity. Constitutive equations for anisotropic and isotropic elastic solids. Formulation and solution of torsion, bending, and flexure problems. Plane, axisymmetric, and three-dimensional problems. 3 units. *Petroski*

210. Intermediate Dynamics. C-L: Mechanical Engineering and Materials Science 210. 3 units. *Dowell*

212. Mechanical Behavior and Fracture of Materials. Historical perspective on structural failure. Fracture mechanics and its application to brittle and ductile fracture; fatigue in structural materials. Analysis of load spectra; fatigue crack growth calculations. 3 units. *Petroski*

215. Urban and Regional Systems Analysis. Identification, formulation, and solution of urban and regional systems problems. Models of population growth and distribution, spatial activity allocation models. Design and analysis of experiments for resource recovery, waste disposal, and transportation planning. Application of matrix algebra in the design and analysis of solid waste processing and resource recovery. Optimization of public service delivery systems, including solid waste collection and disposal, resource recovery, water supply systems, and transportation networks. 3 units. *Pas*

216. Transportation Planning and Policy Analysis. Issues in policy planning and decision making in urban and intercity transportation systems. Transportation legislation. Emphasis on analysis and understanding of government transportation programs and policy. Prerequisite or corequisite: Civil and Environmental Engineering 116 or consent of instructor. C-L: Public Policy Studies 254. 3 units. *Pas*

217. Transportation Systems Analysis. The transportation systems planning process. Quantitative analysis, mathematical modeling and computer simulation techniques for short- and long-range planning and evaluation of transportation systems. Prerequisite or corequisite: Civil and Environmental Engineering 116 or consent of instructor. 3 units. *Pas*

218. Engineering Management and Project Evaluation. Statistical analysis and economics. Data organization, distributions, estimates of parameters, hypothesis testing, analysis of variance. Economic impact assessment, supply and demand forecasting, benefit/cost analysis, economic incentives, public and private finance, input/output analysis. 3 units. *Peirce*

225. Dynamic Engineering Hydrology. Dynamics of the occurrence, circulation, and distribution of water; hydrometeorology; geophysical fluid motions. Precipitation, surface runoff and stream-flow, infiltration, water losses. Hydrograph analysis, catchment characteristics, hydrologic instrumentation, and computer simulation models. Prerequisite: Civil and Environmental Engineering 122 or consent of instructor. 3 units. *Medina or Muga*

227. Groundwater Hydrology and Contaminant Transport. Review of surface hydrology and its interaction with groundwater. The nature of porous media, hydraulic conductivity, and permeability. General hydrodynamic equations of flow in isotropic and anisotropic media. Water quality standards and contaminant

transport processes: advective-dispersive equation for solute transport in saturated porous media. Analytical and numerical methods, selected computer applications. Deterministic versus stochastic models. Applications: leachate from sanitary landfills, industrial lagoons and ponds, subsurface wastewater injection, monitoring of groundwater contamination. Conjunctive surface-subsurface models. Prerequisites: Civil and Environmental Engineering 122 and 123 or consent of instructor. 3 units. *Medina*

232. Reinforced Concrete Design. A critical review of research related to the development of existing codes. Special attention is given to the consideration of temperature change effects, shrinkage, plastic flow, bond, and shear and diagonal tension. Two-way slab and flat plate design. Prerequisite: Civil and Environmental Engineering 133. 3 units. *Biswas*

233. Prestressed Concrete Design. A critical review of research and recent developments in prestressed concrete design. Prestressed tanks, beams, and columns; partial prestressing and composite design. Prerequisite: Civil and Environmental Engineering 133. 3 units. *Biswas*

234. Advanced Structural Design in Metals. Design of metal structures using limit-state theory. Critical review of the basis for Load and Resistance Factor Design (LRFD) specifications. Application to bridge, building, offshore and aerospace structures. Evaluation of contemporary structural systems for planning and preliminary design. Prerequisite: Civil and Environmental Engineering 134 or equivalent. 3 units. *Biswas*

235. Foundation Engineering. An introduction to methods of analysis, design, and construction of foundations. Bearing capacity and settlement of shallow and deep foundations. Soil exploration, excavation and bracing, drainage and stabilization, and underpinning. Foundation vibrations. 3 units. *Hueckel*

236. Earth Structures. An introduction to methods of analysis, design, and construction of earth structures such as dams, embankments, cuts, canals, and airfield and highway pavements. Selection of materials, soil compaction, and stabilization. Theory of seepage, design of wells and drainage collectors. Slope stability and related problems. Theory of layered systems and pavement design procedures. 3 units. *Hueckel*

241. Environmental Engineering Chemistry and Biology. Inorganic and organic chemistry as applied to water and wastewater treatment. Chemical equilibria and kinetics. Population dynamics and energy transfer in metabolic systems. Instrumental analysis, including spectrophotometry, chromatography, and atomic adsorption. Atmospheric chemistry and analytical methods. Prerequisite: Civil and Environmental Engineering 124. 3 units. *Bryers*

243. Unit Operations in Water Treatment. Fundamental bases for design of water and waste treatment systems, including transport, mixing, sedimentation and filtration, gas transfer, coagulation, and biotreatment processes. Prerequisite: Civil and Environmental Engineering 124 or consent of instructor. 3 units. *Vesilind*

245. Pollutant Transport Systems. Distribution of pollutants in natural waters and the atmosphere, diffusive and advective transport phenomena within the natural environment and through artificial conduits and storage/treatment systems. Analytical and numerical prediction methods. Prerequisites: Civil and Environmental Engineering 122 and Mathematics 111 or equivalents. 3 units. *Medina*

246. Water Supply Design. The study of water resources and municipal water requirements including reservoirs, transmission, treatment and distribution systems; methods of collection, treatment, and disposal of municipal and industrial wastewaters. The course includes the preparation of a comprehensive engi-

neering report encompassing all aspects of municipal water and wastewater systems. Field trips to be arranged. Prerequisite: Civil and Environmental Engineering 124 or consent of instructor 3 units. *Vesilind*

248. Solid Waste and Resource Recovery Engineering. Engineering design of resource recovery systems including traditional and advanced technologies. Sanitary landfills and incineration of solid wastes. Energy recovery and recycling municipal refuse. Collection, treatment, and disposal of solid wastes from wastewater treatment. Prerequisite: Civil and Environmental Engineering 124 or consent of instructor. 3 units. *Vesilind*

249. Control of Hazardous and Toxic Waste. Solutions to industrial and municipal hazardous waste management problems. Handling, transportation, processing, storage, and disposal technologies. Upgrading an abandoned disposal site. Economic and regulatory aspects. Case studies. Prerequisite: consent of instructor. 3 units. *Peirce*

251. Systematic Engineering Analysis. Mathematical formulation and numerical analysis of discrete engineering systems with emphasis on theory of structures. Equilibrium and propagation problems in continuum; properties of these systems and their discretization by the trial functions with undetermined parameters. The use of weighted residual methods, finite elements, and finite differences. Prerequisite: senior or graduate standing. 3 units. *Utku*

254. Applications of Finite Element Analysis. Theory of element and material models; models of metals, rock, reinforced concrete, wood, glass, soil, water, and air; analyses of torsion members, shear walls, membranes, plates, shells, solids, and compound structural systems; analysis of soil-structure and fluid-structure systems; prediction of field heating, seepage, and pollution. Prerequisite: Civil and Environmental Engineering 251 or consent of instructor. 3 units. *Melosh*

258. Analysis of Dynamic and Nonlinear Behavior of Structures. Computation of nonlinear response by discretization; models for simulation of geometric, material, and boundary constraint nonlinearities; analysis of limit loads, bifurcations, and snap-through; simulation of super-elastic, plastic, viscoelastic, and slipping materials; prediction of collapsing, ballooning, gapping, metal forming, and welding behavior. Prerequisite: Civil and Environmental Engineering 251 or consent of instructor. 3 units. *Melosh*

265. Advanced Topics in Civil and Environmental Engineering. Opportunity for study of advanced subjects relating to programs within the civil and environmental engineering department tailored to fit the requirements of a small group. 1 to 3 units. *Graduate staff*

280. Engineering Aspects of Physical Oceanography. Study of the dynamic ocean processes of concern to the design engineer. Hydrometeorology, surface wind distribution, mechanics of generation and propagation of surface water waves, theory of periodic waves (linear and nonlinear), wave spectral descriptive models, astronomical tides, storm surge, impulsively generated waves (tsunamis), and wind- and wave-induced forces on various obstructions. Attention is focused on hindcasting-forecasting techniques and selection of design (wave spectra) criteria in terms of specified risk levels. 3 units. *Muga*

281. Experimental Systems. Formulation of experiments; Pi theorem and principles of similitude; data acquisition systems; static and dynamic measurement of displacement, force, and strain; interfacing experiments with digital computers for statistical data analysis; students select, design, perform, and interpret laboratory-scale experiments in areas of fluid systems including environmental and ocean engineering, and in solid systems including structural and basic material behavior. 3 units. *J. F. Wilson*

282. Port, Harbor, and Coastal Engineering. An intensive study of the various types of marine and coastal structures and their functions. Procedures for developing preliminary design alternatives and final design selection will be illustrated via the case history approach. Structures to be considered include piers (solid and open faced), seawalls and bulkheads, breakwaters, jetties, groins, outfalls, pipelines, moored cable array systems, and floating terminals. Each case history will be followed from conception and initial planning through the design stage to construction and postproject evaluation. Normally, there will be an opportunity to participate in an ongoing project. Prerequisite: Civil and Environmental Engineering 280. 3 units. *Muga*

283. Ocean System Dynamics. Formulation of dynamic models for discrete and continuous structures, normal mode analysis, deterministic and stochastic responses to shocks and environmental loading (earthquakes, winds, and waves), introduction to nonlinear dynamic systems, analysis and stability of structural components (beams and cables and large systems such as offshore towers, moored ships, and floating platforms). 3 units. *J. F. Wilson*

301, 302. Fall and Spring Seminars. Current topics in civil and environmental engineering theory and practice. No credit. *Director of Graduate Studies*

399. Special Readings in Civil and Environmental Engineering. Special individual readings in a specific area of study in civil and environmental engineering. Prerequisite: approval of Director of Graduate Studies. 1 to 3 units. *Graduate staff*

COURSES CURRENTLY UNSCHEDULED

202. Advanced Mechanics of Solids II

221. Incompressible Fluid Flow

222. Open Channel Flow

223. Flow Through Porous Media

226. Operational Hydrology

231. Structural Engineering Analysis

238. Rock Mechanics

239. Physical Properties of Soils

247. Air Pollution Control

257. Optimization of Structures

306. Plasticity

336. Advanced Soil Mechanics

337. Elements of Soil Dynamics

350. Advanced Engineering Analysis

ELECTRICAL ENGINEERING

Professor Casey, *Chairman* (130 Engineering); Professor Marinos, *Director of Graduate Studies* (173 Engineering); Professors Fair, Joines, Kerr, Nolte, Pilkington, Trivedi, Wang, and T. G. Wilson; Associate Professor Hacker; Assistant Professors Board, Carroll, Dollas, Dugan, George, Massoud; Research Assistant Professors Frenzel and Wong; Professor Emeritus Owen

A student may specialize in any one of the following fields in working toward either the M.S. or the Ph.D. degree with a major in electrical engineering: computer-aided design, computer engineering, detection and estimation theory, digital signal processing, electromagnetic fields and microwaves, integrated circuit design and fabrication, microprocessor systems, robotics and control systems,

solid-state devices and materials, solid-state power conditioning, and VLSI circuit design.

Recommended prerequisites for the graduate courses in electrical engineering include a knowledge of basic mathematics and physics, electric networks, and system theory. Students in doubt about their background for enrollment in specific courses should discuss the matter with the Director of Graduate Studies. The M.S. degree program includes either a thesis or a project and an oral examination. A qualifying examination is required for the Ph.D. degree program. This examination is intended to test both the breadth and depth of the student's understanding of basic electrical engineering concepts. There is no foreign language requirement.

202. Digital Communication Systems. Transmission of pulse signals over analog channels at baseband and high frequency. Effects of channel amplitude and phase distortion, multipath, and noise. Typical signaling formats and their autocorrelation functions and power spectra. Theory and design of adaptive transversal filters for the elimination of intersymbol interference. Design of digital transversal matched filters to reduce error probabilities in the presence of noise. Optimum pulse shaping techniques and Nyquist channel characteristics. Discrete Fourier transforms, FFT's, and their relation to continuous Fourier transforms. Introduction to the channel characteristics and sources of noise in optical fiber channels. Prerequisites: Electrical Engineering 186, and Mathematics 135 or Electrical Engineering 203, or permission of instructor. 3 units. *Kerr*

203. Random Signals and Noise. Introduction to mathematical methods of describing and analyzing random signals and noise. Review of basic probability theory; joint, conditional, and marginal distributions; random processes. Time and ensemble averages, correlation, and power spectra. Optimum linear smoothing and predicting filters. Introduction to optimum signal detection and parameter estimation. 3 units. *Kerr or Nolte*

204. Computer Network Architecture. The architecture of computer communication networks and the hardware and software required to implement the protocols that define the architecture. Basic communication theory, transmission technology, private and common carrier facilities. International standards. Satellite communications and local area networks. Performance analysis and modeling of communication networks. Prerequisite: Electrical Engineering 157. C-L: Computer Science 204. 3 units. *Strole*

205. Signal Detection and Extraction Theory. Introduction to signal detection and information extraction theory from a statistical decision theory viewpoint. Subject areas covered within the context of a digital environment are decision theory, detection and estimation of known and random signals in noise, estimation of parameters and adaptive recursive digital filtering, and decision processes with finite memory. Applications to problems in communication theory. Prerequisite: Electrical Engineering 203 or consent of instructor. 3 units. *Nolte*

206. Digital Signal Processing. Introduction to the fundamentals of processing signals by digital techniques with applications to practical problems. Discrete time signals and systems, elements of the Z-transform, discrete Fourier transforms, digital filter design techniques, fast Fourier transforms, and discrete random signals. 3 units. *Nolte*

207. Fault-Tolerant and Testable Computer Systems. Faults and failure mechanisms, test generation techniques and diagnostic program development for detection and location of faults in digital networks; design for testability, redundancy techniques, self-checking and fail-safe networks, fault-tolerant computer architectures. Prerequisite: Electrical Engineering 157 or equivalent. C-L: Computer Science 207. Fall. 3 units. *Marinos*

208. Digital Computer Design. Structural organization and hardware design of digital computer systems. Arithmetic unit, switching matrices, memory organization, central processing unit (CPU), I/O unit, and microprogram control. Detailed design and simulation of a general-purpose computer system. Computer systems based on cellular structures, hardware compilers, and parallel processing architectures are also discussed. Prerequisite: Electrical Engineering 157 or consent of instructor. C-L: Computer Science 208. Spring. 3 units. *Marinos*

209. Microprocessor Fundamentals and Applications. Various state-of-the-art microprocessor chips and their associated instruction sets, microcomputer architectures, comparative study of various microprocessor designs, microprocessor-based system design illustrated by several carefully selected design projects. Prerequisites: Electrical Engineering 157 and consent of instructor. Fall. C-L: Computer Science 209. 4 units. *Carroll or George*

210. Introduction to VLSI Systems. A study of devices, circuits, fabrication technology, logic design techniques, and system architecture intended to provide the student with an understanding of the underlying physics and design techniques of VLSI systems. Students are required to complete the design of a digital subsystem in NMOS. Prerequisites: Electrical Engineering 157 and 216 or consent of instructor. Spring. 3 units. *Carroll*

211. Quantum Mechanics. Wave mechanics and elementary applications, free particle motion, Schrödinger equation, approximation methods. Fall. 3 units. *Staff*

213. Modern Optics. Optical processes including the propagation of light, coherence, interference, and diffraction. Consideration of the optical properties of solids with applications of these concepts to lasers and modern optical devices. 3 units. *Guenther or Hacker*

214. Introduction to Solid-State Physics. Discussion of solid-state phenomena including crystalline structures, thermal properties, free electron theory of metals, and band theory of semiconductors with emphasis on understanding the electrical, magnetic, and optical properties of solids. Prerequisite: Physics 161 or equivalent. C-L: Physics 214. 3 units. *Hacker*

215. Semiconductor Physics. A quantitative treatment of the physical processes that underlie semiconductor device operation. Topics include: band theory and conduction phenomena; equilibrium and nonequilibrium charge carrier distributions; charge generation, injection, and recombination; drift and diffusion processes. Prerequisite: Electrical Engineering 211 or consent of instructor. 3 units. *Casey or Hacker*

216. Devices for Integrated Circuits. Basic operating concepts of the devices that are used in integrated circuits: Schottky-barriers, ohmic contacts, p-n junctions, bipolar transistors, and Si MOS capacitors and field-effect transistors. Basic MOS logic circuits. Selected laboratory work. Fall. 3 units. *Casey*

218. Integrated Circuit Engineering. Basic processing techniques and layout technology for integrated circuits. Photolithography, diffusion, oxidation, ion implantation, and metallization. Design, fabrication, and testing of integrated circuits. Prerequisite: Electrical Engineering 216. 4 units. *Casey or Fair*

219. Digital Integrated Circuits. Analysis and design of digital integrated circuits. MOSFET and bipolar devices. SPICE models. Major logic families such as NMOS, CMOS, TTL, ECL, and I²L as well as regenerative logic circuits and memories. Circuit design considerations for LSI and VLSI. Prerequisites: Electrical Engineering 157 and 216. 3 units. *Massoud*

224. Advanced Electronic Circuits. Application of integrated circuits in analog systems. A study of differential, operational, and other multistage amplifiers; feedback, filter design, and other topics. Some laboratory and computer simulation work. Prerequisite: Electrical Engineering 161 or equivalent. 3 units. *George*

225. Microwave Electronic Circuits. Microwave circuit analysis and design techniques. Properties of planar transmission lines for integrated circuits. Matrix and computer-aided methods for analysis and design of circuit components. Analysis and design of input, output, and interstage networks for microwave transistor amplifiers and oscillators. Prerequisite: Electrical Engineering 161 or equivalent. 3 units. *Joines*

234. Power Electronics: High-Power Circuits. Basic principles of analysis and design of electronic power control and conversion circuits with particular emphasis on thyristor (SCRs, TRIACs, etc.) circuits. Characteristics of high-power semiconductors, commutating circuits, AC voltage controllers, AC-to-AC controlled rectifiers, DC-to-DC converters, DC-to-AC inverters, AC-to-AC converters. Laboratory. Prerequisite: Electrical Engineering 161 or equivalent. 4 units. *T. G. Wilson*

235. Nonlinear Magnetic and Semiconductor Power Converters. Nonlinear magnetic and semiconductor switching characteristics for transient and steady-state analysis of power electronic circuits. Design of saturable and nonsaturating magnetic devices. State-plane analysis of negative-resistance oscillators and self-oscillating inverters. Laboratory. Prerequisite: Electrical Engineering 161 or equivalent. 4 units. *T. G. Wilson*

236. Energy-Storage Power Converters. Analysis and design of switch-mode electronic power converters utilizing energy-storage principles. Determination of large-signal and small-signal dynamic response and stability of closed-loop regulated converters. Extensive use of computer-aided analysis, design and measurement techniques. Laboratory. Prerequisite: Electrical Engineering 161 or equivalent. 4 units. *T. G. Wilson*

241. Linear Systems. Modeling of multiple input-output linear systems in the frequency and time domains. Matrix differential and difference equations and their solutions; state variables. Digital simulation of differential systems. Fourier analysis of signals and systems. Transform techniques applied to state variable models. State-space models of distributed systems. 3 units. *Kerr or Wang*

250. Introduction to Robotics. Fundamental notions in robotics, basic configurations of manipulator arm designs, coordinate transformations, control of robot actions, robot programming, artificial intelligence; machine vision, force, touch, and other sensory systems; selected laboratory assignments. Prerequisites: Electrical Engineering 112 and consent of instructor. 3 units. *Wang*

251. Pattern Classification and Recognition. Parameter estimation and supervised learning; nonparametric techniques; linear discriminant functions; clustering; language theory related to pattern recognition; examples from areas such as character and severe weather recognition, classification of community health data, recognition of geometrical configurations, algorithms for recognizing low resolution touch-sensor array signatures and 3-D objects. Prerequisite: consent of instructor. 3 units. *Wang*

252. Computer Systems Organization. C-L: Computer Science 252. 3 units. *Patrick or Trivedi*

265. Advanced Topics in Electrical Engineering. Opportunity for study of advanced subjects related to programs within the electrical engineering depart-

ment tailored to fit the requirements of a small group. Prerequisites: approval of Director of Graduate Studies and instructor. 1 to 4 units. *Staff*

271. Electromagnetic Theory. The classical theory of Maxwell's equations; electrostatics, magnetostatics, boundary value problems including numerical solutions, currents and their interactions, and force and energy relations. Three class sessions. Prerequisite: consent of instructor. 3 units. *Hacker or Joines*

272. Electromagnetic Communication Systems. Review of fundamental laws of Maxwell, Gauss, Ampere, and Faraday. Elements of waveguide propagation and antenna radiation. Analysis of antenna arrays by images. Determination of gain, loss, and noise temperature parameters for terrestrial and satellite electromagnetic communication systems. Prerequisite: Electrical Engineering 164 or 271. 3 units. *Joines*

273. Optical Communication Systems. Mathematical methods, physical ideas, and device concepts of optoelectronics. Maxwell's equations, and definitions of energy density and power flow. Transmission and reflection of plane waves at interfaces. Optical resonators, waveguides, fibers, and detectors are also presented. Prerequisite: Electrical Engineering 143 or equivalent. 3 units. *Joines*

308. Advanced Topics in Digital Systems. A selection of advanced topics from the areas of digital computer architectures and fault-tolerant computer design. Prerequisite: Electrical Engineering 208 or equivalent. C-L: Computer Science 308. 3 units. *Marinos*

310. CMOS VLSI Design. A second course in VLSI, aimed at the design of VLSI systems in CMOS. The main thrusts of the course will be (1) to provide enough background in the theory of CMOS circuits to understand circuit level trade-offs; (2) to introduce a symbolic design system and its supporting software, which greatly aid the design process; (3) to examine sample chip designs with an eye to understanding competitive design methodologies. Students will complete a CMOS-oriented project comprising the design and implementation of either a hardware or a software subsystem. Prerequisite: Electrical Engineering 210 or equivalent. C-L: Computer Science 310. 3 units. *Staff*

316. Advanced Physics of Semiconductor Devices. Semiconductor materials: band structure and carrier statistics. Advanced treatments of metal-semiconductor contacts, Schottky barriers, p-n junctions, bipolar transistors (charge-control and Gummel-Poon models), and field-effect transistors (short channel effects, scaling theory, subthreshold conduction, nonuniformly doped substrates, surface and buried-channel devices, hot-electron effects). Device modeling in two dimensions using PISCES. Prerequisite: Electrical Engineering 216. 3 units. *Massoud and Goodwin-Johansson.*

320. Integrated Circuit Fabrication Laboratory. Introduction to IC fabrication processes. Device layout. Mask design and technology. Wafer cleaning, etching, thermal oxidation, thermal diffusion, lithography, and metallization. Laboratory fabrication and characterization of basic IC elements (p-n junctions, resistors, MOS capacitors, gated diodes, and MOSFETs). Use of four-point probe, ellipsometer, spreading resistance probe, scanning electron microscope, and evaporation system. Testing of basic inverters and gates. Prerequisite: Electrical Engineering 218. 3 units. *Massoud*

333. Electronic Properties of Submicron Solid-State Devices. Doping, disordering, and grading in heterojunctions and superlattices. MOCVD and MBE growth techniques. Physical properties of submicron electronic devices, high-speed transport, mobility, energy band structure, and scattering processes. Classical and quantum transport, quantum state transfer, controlled deformation of electron wave functions, mobility modulation, and phonon dynamics. Two dimen-

sional electron gases and plasmons. Monte Carlo simulation of submicron device performance. Current research and recent developments will be emphasized. Prerequisite: Quantum mechanics. C-L: Physics 333. 3 units. *Stroscio*

399. Special Readings in Electrical Engineering. Special individual readings in a specified area of study in electrical engineering. Prerequisite: approval of Director of Graduate Studies. 1 to 4 units. *Graduate staff*

COURSES CURRENTLY UNSCHEDULED

217. Lasers

222. Nonlinear Analysis

226. Modeling/Computer-Aided Analysis of Electronic Systems

227. Network Synthesis

243. Advanced Linear Systems Theory

272. Electromagnetic Communication Systems

302. Applied Information Theory and Statistical Estimation

305. Advanced Topics in Signal Processing

317. Quantum Electronics

324. Nonlinear Oscillations in Physical Systems

342. Optimal Control Theory

371. Advanced Electromagnetic Theory

373. Selected Topics in Field Theory

MECHANICAL ENGINEERING AND MATERIALS SCIENCE

Professor Hochmuth, *Chairman* (142A Engineering); Professor Harman, *Director of Graduate Studies* (145 Engineering); Professors Bejan, Cocks, Dowell, Garg, Gösele, Pearsall, Shaughnessy, Shepard, and Tan; Associate Professors Bliss, Jones, Quinlan, and Wright; Assistant Professors Buzzard and Knight; Associate Professor Emeritus Elsevier

The department offers programs of study and research leading to the M.S. and Ph.D. degrees in both Mechanical Engineering and Materials Science. Current research areas available include: Heat transfer in free convection and in porous media, two-phase transport processes, biomechanics, cooling of electronic equipment, thermal performance of buildings, power generation, thermal design by entropy minimization, solar energy utilization, environmental turbulence and laser-Doppler anemometry, vortex dynamics, electrohydrodynamics, aeroelasticity, chaotic motion, vibrations and acoustics of dynamic structures, sound propagation in porous media and absorbing materials, nonlinear control systems, robotics, computer-aided design, finite element techniques, expert systems, bearing design and lubrication, failure analysis and product design, positron annihilation spectroscopy, polymer science, point defects and diffusion in semiconductors, electron energy transfer in solids and liquids, ecodynamic systems engineering, thermokinetics and thermochemical control of biological processes, and applications of system dynamics to technology assessment.

202. Engineering Thermodynamics. General thermodynamic relationships and continuum properties of real substances. Availability and second law analysis of energy conversion processes. Low temperatures and the third law of thermodynamics. Reaction and multiphase equilibrium. Statistical thermodynamics of simple systems. 3 units. *Bejan and Harman*

205. Biochemical Engineering. Mathematical analysis of the effects of substrate concentration, pH, temperature, and chemical inhibitors on the rate and yield of biological processes. Enzyme kinetics. Kinetics of cell growth and metabolite production in batch and continuous culture. Design of bioreactors for microbial, mammalian, and plant cell culture. Prerequisites: calculus and a course in microbial physiology or biochemistry. 3 units. *Quinlan*

206. Optimization of Bioprocess Kinetics. Concepts and mathematical modeling techniques needed to maximize the rates and yields at which cells produce biomass and metabolites. Prerequisite: Mechanical Engineering 205. 3 units. *Quinlan*

210. Intermediate Dynamics. Comprehensive treatment of space kinematics, kinetics of particles and rigid bodies; generalized coordinates and Lagrange's equations; introduction to stability, nonlinear, and random dynamic analysis of flexible, continuous systems. C-L: Civil and Environmental Engineering 210. 3 units. *Dowell*

211. Theoretical and Applied Polymer Science. An advanced course in materials science and engineering, dealing specifically with the structure and properties of polymers. Particular attention is paid to recent developments in the processing and use of modern plastics and fibers. Product design is considered in terms of polymer structures, processing techniques, and properties. 3 units. *Clark or Pearsall*

212. Electronic Materials. An advanced course in materials science and engineering dealing with the various materials important for solid state electronics including semiconductors, ceramics, and polymers. Emphasis is placed on thermodynamic concepts and on defects in these materials. Materials preparation and modification methods for technological applications are discussed in detail. Prerequisite: Engineering 83. 3 units. *Cocks, Gösele, or Tan*

214. Corrosion and Corrosion Control. Effects of environments on the design and utilization of modern engineering alloys. Theory and mechanisms of corrosion, particularly in seawater and atmospheric environments. Microstructural aspects of diffusion, oxidation, hot corrosion, and stress corrosion. Prerequisite: Engineering 83. 3 units. *Cocks or Jones*

215. Biomedical Materials and Artificial Organs. C-L: Biomedical Engineering 215. 3 units. *Clark*

216. Materials Science and Solar Technology. All aspects of materials science as related to solar energy development. Emphasis is placed on photovoltaic materials and devices, including the relationship of conversion efficiency to material properties and solar cell design. 3 units. *Cocks*

217. Fracture of Engineering Materials. Conventional design concepts and their relationship to the occurence of fracture. Linear elastic and general yield fracture mechanics. Microscopic plastic deformation and crack propagation. The relationship between macroscopic and microscopic aspects of fracture. Time dependent fracture. Fracture of specific materials. Prerequisites: Engineering 83 and Mechanical Engineering 115. 3 units. *Jones*

218. Thermodynamics and Thermokinetics of Materials. Thermodynamic and thermokinetic fundamentals and their application to materials problems such as alloying, solid solution formation, and mass transport. Topics covered include the laws of thermodynamics, reactions and reaction rates, Gibbs and Helmholtz free energy, chemical potential, phase equilibria in semiconductor and metallic systems, behavior of solutions, phase diagrams, activation energies, and the transport equations. 3 units. *Cocks, Jones, Pearsall, or Shepard*

219. Applied Surface Science: Crystal Growth and Analytical Techniques. Fundamentals of surfaces processes and particle-surface interactions. Topics covered include adsorption, accommodation, elemental sticking coefficients, adatom diffusion, nucleation, thin film vapor phase growth (MBE, CVD, sputtering, etc.), and surface spectroscopies (AES, XPS, RBS, SIMS, etc.). 3 units. *Staff*

221. Compressible Fluid Flow. Basic concepts of the flow of gases from the subsonic to the hypersonic regime. Effects of friction, heat transfer, and shock on one-dimensional inviscid flow. Potential theory, oblique shock waves, and special calculation techniques in two-dimensional flow. 3 units. *Harman or Shaughnessy*

222. Heat Transfer. Analytical and numerical treatment of conduction heat transfer. Boundary layer treatment of convection heat transfer. Boiling and condensing heat transfer. Gas radiation. Selected engineering applications. Prerequisite: Mechanical Engineering 150. 3 units. *Buzzard or Chaddock*

224. An Introduction to Turbulence. Flow instability and the transition to turbulence. Physical characteristics of turbulent flows, averaging, and the Reynolds equation. Turbulent transport and mixing length theories. The statistical description of turbulence, correlations, and spectra. Fourier transforms. Measurement techniques. 3 units. *Shaughnessy*

226. Intermediate Fluid Mechanics. A survey of the principal concepts and equations of fluid mechanics. Fluid properties. Statics. Basic equations for the control volume. The differential equations of fluid motion. Stream function. Irrotational flow. Navier-Stokes equations. Kelvin's and Crocco's theorem. Applications to two-dimensional incompressible potential flow and to viscous flow in boundary layers. 3 units. *Shaughnessy*

227. Advanced Fluid Mechanics. Flow of a uniform incompressible viscous fluid. Exact solutions to the Navier-Stokes equation. Similarity methods. Irrotational flow theory and its applications. Elements of boundary layer theory. Prerequisite: Mechanical Engineering 226 or consent of instructor. 3 units. *Shaughnessy*

230. Modern Control and Dynamic Systems. Dynamic modeling of complex linear and nonlinear physical systems involving the storage and transfer of matter and energy. Unified treatment of active and passive mechanical, electrical, and fluid systems. State-space formulation of physical systems. Time and frequency-domain representation. Controllability and observability concepts. System response using analytical and computational techniques. Lyapunov method for system stability. Modification of system characteristics using feedback control and compensation. Emphasis on application of techniques to physical systems. 3 units. *Garg or Wright*

235. Advanced Mechanical Vibrations. Analytical and experimental procedures applied to design of machines and systems for adequate vibration control. Determination of eigenvalues and eigenvectors by iteration and computer techniques, transfer matrices applied to lumped and distributed systems, analytical and numerical methods of obtaining the pulse response of plane and three-dimensional multi-mass systems, convolution and data processing, introduction to random vibration. 3 units. *Staff*

236. Engineering Acoustics. Fundamentals of acoustics including sound generation, propagation, reflection, absorption, and scattering. Emphasis on basic principles and analytical methods in the description of wave motion and the characterization of sound fields. Applications including topics from noise control, sound, reproduction, architectural acoustics, and aerodynamic noise. Occasional classroom or laboratory demonstration. Prerequisites: Mathematics 111 and Engineering 123 or consent of instructor. 2 units. *Bliss*

240. Patent Technology and Law for Engineers. The use of patents as a technological data base is emphasized including information retrieval in selected engineering disciplines. Fundamentals of patent law and patent office procedures. 3 units. *Cocks*

241. Advanced Mechanical Design. A study of those processes in mechanical design which occur after a prototype has been developed. Areas of study may include prototype testing and evaluation, computer analysis, marketing, CAD, redesign, detail drafting, manufacturing processes for mass production, economic analysis, patents, and entrepreneurial activities. Semester projects using design teams will be used to study these areas. Prerequisite: Mechanical Engineering 141. 3 units. *Knight*

245. Applications in Expert Systems. A comprehensive introduction to the key practical principles, techniques, and tools being used to implement knowledge-based systems. The classic MYCIN system is studied in detail to provide historic perspective. Current systems employing combinations of production rules, prototypical knowledge, and frame-based case studies are also introduced. Student term projects consist of the development of individual, unique expert systems using the Texas Instruments Personal Consultant. Knowledge of LISP is not a prerequisite. 3 units. *Wright*

254. Solar Energy Thermal Processes. Solar radiation instrumentation, measurements, data, and estimation. Radiation heat transfer characteristics of opaque materials and partially transparent media. Performance and design calculations for flatplate and focusing collectors. Thermal energy storage. Solar water heating and heating and cooling of buildings. Economics and life cycle costing studies for solar installations. Survey of research, development, and demonstration projects on solar thermal processes. 3 units. *Chaddock*

265. Advanced Topics in Mechanical Engineering. Opportunity for study of advanced subjects related to programs within mechanical engineering tailored to fit the requirements of a small group. Prerequisites: approval of Director of Undergraduate or Graduate Studies and instructor. 1 to 3 units. *Staff*

270. Robot Control and Automation. Review of kinematics and dynamics of robotic devices; mechanical considerations in design of automated systems and processes, hydraulic and pneumatic control of components and circuits; stability analysis of robots involving nonlinearities; robotic sensors and interfacing; flexible manufacturing; man-machine interaction and safety considerations. Prerequisites: Mechanical Engineering 230 or equivalent and consent of instructor. 3 units. *Garg*

277. Optimization Methods for Mechanical Design. Definition of optimal design. Methodology of constructing quantitative mathematical models. Nonlinear programming methods for finding "best" combination of design variables: minimizing steps, gradient methods, flexible tolerance techniques for unconstrained and constrained problems. Emphasis on computer applications and term projects. Prerequisite: consent of instructor. 3 units. *Wright*

302. Advanced Thermodynamics. Classical thermodynamics of inherently irreversible processes. Quantum and statistical thermodynamic analysis of properties of real substances and processes. Principles of general thermodynamics. 3 units. *Bejan and Harman*

323. Convective Heat Transfer. Models and equations for fluid motion, the general energy equation, and transport properties. Exact, approximate, and boundary layer solutions for laminar flow heat transfer problems. Use of the principle of similarity and analogy in the solution of turbulent flow heat transfer. Two-phase flow, nucleation, boiling, and condensation heat and mass transfer. Prerequisite: Mathematics 285. 3 units. *Bejan and Chaddock*

324. Conduction and Radiation Heat Transfer. Conduction heat transfer in steady and transient state. Radiation exchange involving absorbing and emitting media including gases and flames, combined conduction and radiation, and combined convection and radiation. Exact and approximate methods of solution including separation of variables, transform calculus, numerical procedures, and integral and variational methods. Prerequisites: Mathematics 230 and Mechanical Engineering 222 or equivalent. 3 units. *Buzzard*

325. Aeroelasticity. A study of the statics and dynamics of fluid/structural interaction. Topics covered include static aeroelasticity (divergence, control surface reversal), dynamic aeroelasticity (flutter, gust response), unsteady aerodynamics (subsonic, supersonic, and transonic flow), and a review of the recent literature including nonlinear effects such as chaotic oscillations. Prerequisites: Mathematics 230 and consent of instructor. 3 units. *Dowell*

331. Nonlinear Control Systems. Analytical, computational, and graphical techniques for solution of nonlinear systems; Krylov and Bogoliubov asymptotic method; describing function techniques for analysis and design; Liapunov functions and Lure's methods for stability analysis; Aizerman and Kalman conjectures; Popov, circle, and other frequency-domain stability criteria for analysis and synthesis. Prerequisite: Mechanical Engineering 230 or consent of instructor. 3 units. *Garg or Wright*

399. Special Readings in Mechanical Engineering. Individual readings in advanced study and research areas of mechanical engineering. Prerequisite: approval of Director of Graduate Studies. 1 to 3 units. *Staff*

COURSES CURRENTLY UNSCHEDULED

213. Advanced Materials Science

223. Principles and Design of Heat Transfer Equipment

232. Nonlinear Analysis

300. Advanced Projects in Mechanical Engineering

311. Behavior of Crystalline Solids

322. Mechanics of Viscous Fluids

327. Homogeneous Turbulence

328. Turbulent Shear Flow

333. Seminar in Control Systems

335. Analytical Methods in Vibrations

372. Finite Element Techniques in Design

English

Professor Fish, *Chairman* (323 Allen); Professor Torgovnick, *Assistant Chairman*; Professor Gleckner, *Director of Graduate Studies* (316 Allen); Professors Anderson, Budd, Cady, Ferguson, Jackson, Lentricchia, Nygard, A. Patterson, L. Patterson, Price, Randall, Ryals, B. H. Smith, G. Smith, Strandberg, Tompkins, G. Williams, and K. Williams; Associate Professors Applewhite, Butters, Clum, DeNeef, Gerber, Jones, Mellown, and Pope; Assistant Professors Gaines, Gopen, and Porter

The department offers graduate work leading to the A.M. and Ph.D. degrees, although normally only students seeking the doctorate are admitted to the department. The A.M. degree, if not already earned elsewhere, will be taken by students en route to the Ph.D. and by those who elect to leave the doctoral

program. A statement of the requirements for the A.M. and Ph.D. degrees may be obtained from the Director of Graduate Studies. The department requires a reading knowledge of at least one foreign language for the Ph.D. degree, the specific language (or languages) to be determined by the student's doctoral committee.

Applicants to the program in English should also furnish a copy (not returnable) of a term paper or other essay in nonfiction prose submitted in fulfillment of a requirement in an academic course.

For Seniors and Graduates

208. History of the English Language. Introductory survey of the changes in sounds, forms, and vocabulary of the English language from its beginning to the present, with emphasis on the evolution of the language as a medium of literary expression. C-L: Medieval and Renaissance Studies. 3 units. *Butters or Nygard*

209. Present-Day English. A survey of contemporary linguistic theories applied to modern English; designed for students of literature and teachers of English. 3 units. *Butters or Nygard*

212. Middle English Literature: 1100 to 1500. Selected topics. C-L: Medieval and Renaissance Studies. 3 units. *Fish, Gopen, Nygard, or L. Patterson*

221. Renaissance Prose and Poetry: 1500 to 1660. Selected topics. C-L: Medieval and Renaissance Studies. 3 units. *DeNeef, Fish, A. Patterson, Randall, or G. Williams*

225. Renaissance Drama: 1500 to 1642. Selected topics. C-L: Medieval and Renaissance Studies. 3 units. *A. Patterson, Randall, or G. Williams*

235. Restoration and Eighteenth-Century Literature: 1660 to 1800. Selected topics. 3 units. *Ferguson or Jackson*

241. Romantic Literature: 1790 to 1830. Selected topics. 3 units. *Applewhite, Gleckner, or Jackson*

245. Victorian Literature: 1830 to 1900. Selected topics. 3 units. *Ryals*

251. British Literature since 1900. Selected topics. 3 units. *Mellown or Smith*

263. American Literature to 1865. Selected topics. 3 units. *Anderson, Jones, or Tompkins*

267. American Literature: 1865 to 1915. Selected topics. 3 units. *Budd, Cady, or K. Williams*

269. American Women Writers. Selected topics. C-L: Women's Studies. 3 units. *Pope or Tompkins*

275. American Literature since 1915. Selected topics. 3 units. *Lentricchia, Pope, or Strandberg*

281. Studies in Genre. History, criticism, and theory of literary genres such as the novel, pastoral, epic, and drama. 3 units. *Staff*

283. Feminist Theory and the Humanities. C-L: Religion 269 and Women's Studies. 3 units. *Clark, Orr, Pope, or Tompkins*

288. Special Topics. Subjects, areas, or themes that cut across historical eras, several national literatures, or genres. 3 units. *Staff*

312. Studies in Middle English Literature. C-L: Medieval and Renaissance Studies. 3 units. *Fish, Nygard, or L. Patterson*

315. Studies in Chaucer. C-L: Medieval and Renaissance Studies. 3 units. *Fish, Nygard, or L. Patterson*

321. Studies in Renaissance Literature. C-L: Medieval and Renaissance Studies. 3 units. *DeNeef, Fish, A. Patterson, Randall, or G. Williams*

324. Studies in Shakespeare. C-L: Medieval and Renaissance Studies. 3 units. *A. Patterson, Porter, or G. Williams*

329. Studies in Milton. C-L: Medieval and Renaissance Studies. 3 units. *DeNeef or Fish*

337. Studies in Augustanism. 3 units. *Ferguson or Jackson*

338. Studies in a Major Augustan Author. 3 units. *Ferguson, Gleckner, or Jackson*

341. Studies in Romanticism. 3 units. *Gleckner or Jackson*

347. Studies in Victorianism. 3 units. *Ryals*

348. Studies in a Major Nineteenth-Century Author. 3 units. *Gleckner, Jackson, or Ryals*

353. Studies in Modern British Literature. 3 units. *Mellown, Smith, or Torgovnick*

361. Studies in American Literature before 1915. 3 units. *Anderson, Budd, Cady, Jones, Tompkins, or K. Williams*

368. Studies in a Major American Author before 1915. 3 units. *Anderson, Budd, Cady, Jones, Tompkins, or K. Williams*

375. Studies in Modern American Literature. 3 units. *Lentricchia, Pope, or Strandberg*

376. Studies in a Modern Author (British or American). 3 units. *Lentricchia, Mellown, Pope, Smith, Strandberg, or Torgovnick*

381. Special Topics Seminar. 3 units. *Staff*

383. Studies in Textual Criticism. C-L: Medieval and Renaissance Studies. 3 units. *A. Patterson or G. Williams*

385. Studies in Literary Criticism. 3 units. *Staff*

390. Composition Theory and Pedagogy. Methodologies of teaching composition, with special emphasis on the theories of structural stylistics employed in the University Writing Program (UWP). The course also deals with psychological, sociological, and dramatic considerations in becoming a teacher. All students registering in the course must hold a tutorship in the UWP, must attend the UWP training seminar and all scheduled UWP staff meetings, and will be observed teaching by a UWP director. 3 units, ungraded. *Gopen*

391. Tutorial in Special Topics. 3 units. *Staff*

392. Tutorial in Journal Editing. Systematic exposure to all phases of academic journal editing. Restricted to holders of journal editing internships. 3 units, ungraded. *Budd, Cady, or Lentricchia*

393. Professionalism, Theory, and Power in Legal and Literary Studies. C-L: Law 594. 3 units. *S. Fish*

COURSES CURRENTLY UNSCHEDULED

310. Studies in Old English Literature

380. Studies in Ballad and Folksong

TUTORIALS

Tutorials in specialized subjects of study not available in the courses listed above may be offered to single students or to small groups. Instruction normally

will be conducted in weekly sessions, or more frequently if the instructor wishes. Emphasis will be on independent reading and investigation, and on oral and written reports. A substantial amount of writing will be required.

Permission of the Instructor and the Director of Graduate Studies is required.

Forestry and Environmental Studies

Professor Dutrow, *Dean* (216 Biological Sciences); Professor Stambaugh, *Director of Graduate Studies* (011 Biological Sciences); Professors Jayne, Knoerr; Associate Professors Christensen, Hyde, Reckhow, and Richardson; Assistant Professors Di Giulio, Maguire, Marin, and Royer; Professors Emeriti Anderson, Hellmers, and Philpott; Adjunct Professors Boyce, Condrell, Dieter, Sizemore and Steen; Adjunct Associate Professor Healy; Adjunct Assistant Professor Alig; Research Professor Yoho

Major and minor work is offered in the areas of natural resource science/ecology, natural resource systems science, and natural resource economics/policy. Programs of study and research lead to the A.M., M.S., and Ph.D. degrees. College graduates who have a bachelor's degree in one of the natural or social sciences, forestry, engineering, business, or environmental science will be considered for admission to a degree program. Students will be restricted to the particular fields of specialization for which they are qualified academically. Graduate School programs usually concentrate on some area of natural resource science/ecology, systems science, or economics/policy, while study in resource management is more commonly followed in one of the professional master's degree programs of the School of Forestry and Environmental Studies. For more complete program descriptions and information on professional training in forestry or environmental studies, the *Bulletin of Duke University: School of Forestry and Environmental Studies* should be consulted.

The specific degrees available in forestry and related natural resources through the Graduate School are: the A.M. (with or without a thesis), M.S. (with a thesis), and the Ph.D. Students majoring in forestry or environmental studies may be required to demonstrate satisfactory knowledge of one or two foreign languages for the Ph.D. degree. More information on degree and language requirements can be found in the registration and regulations section of this bulletin.

200. Student Projects. Prerequisite: consent of the dean of the School of Forestry and Environmental Studies. Units to be arranged. *Staff*

201. Field Studies. Units to be arranged. *Staff*

204. Forest Inventory, Growth, and Yield. Measurement of land and forests for purposes of management, appraisal, purchase, and sale. Techniques for predicting the growth and future yield of stands by various methods. 3 units. Fall. *Davison*

205. Silviculture. Consideration of the decision-making processes by which prescriptions are formulated for regeneration, tending, and harvesting of forest stands. Biological factors underlying stand manipulation are stressed and economic, harvesting, and utilization variables are discussed as appropriate. Emphasis on principles and techniques that transcend vegetational types or geographic regions. Spring. 4 units. *Oren*

207. Forest Pest Management. Fundamentals of entomology and plant pathology as appropriate to understanding the impacts of insects and diseases on forest productivity and their assessment for integration into forest management. Regional case examples and complexes are evaluated in terms of pest-population, forest-stand dynamics; economic and societal constraints; treatment strategies; monitor-

ing systems; and benefit-cost analysis. This approach seeks to develop predictive capabilities in long-range pest management and decision making. Laboratory is largely field oriented to focus on diagnostics and impact analysis. Fall. 3 units; 4 units with laboratory. *Stambaugh*

208. Fire Behavior and Use. Impacts of destructive agents upon forests; principles of combustion, fire behavior, danger measurement, and suppression; use of fire in forest management. Spring. 3 units. *Staff*

210L. Forest Pathology. Diseases of North American forests and their timbers, with emphasis on current literature and management strategies. Field and laboratory diagnosis. Offered on demand. 3 units; 4 units with laboratory. *Stambaugh*

211L. Applied Ecology and Ecosystem Management. An application of ecological principles to applied resource and environmental problems with an emphasis on the ecosystem as a basic working unit. Perspectives include such topics as land/water interactions, the patchiness concept, succession, energy flow, productivity, mineral cycling, perturbation effects on ecosystems, and limiting factors. Laboratory studies will focus on the team approach to analyzing the biotic and abiotic components of the ecosystem and impact analysis. Fall. 4 units. *Richardson*

213. Forest Ecosystems. Introduction to basic processes regulating ecosystem development, structure and function; examination of ecosystem concepts and the effects of management activities on ecosystem processes and patterns. Elective laboratory, taught as FES 214, introduces field aspects of forest ecology. Fall. 3 units. *Staff*

214. Ecology of Southern Appalachian Forests. One-week introduction to forest ecosystems in the southern Appalachians, including species identification, major forest types, patterns in ecosystem distributions, and effects of human activities. 1 unit, intensive. *Staff*

215. Environmental Physiology. Examination of the concepts of tolerance, limiting factors, bioenergetics, nutrition, stress physiology, homeostasis, and alleopathy for both plant and animal life. Discussion of procedures for and examples of monitoring physiological perturbations due to resource manipulation. Spring, even-numbered years. 3 units. *Di Giulio and Richardson*

216. Applied Population Ecology. Discussion of population dynamics of natural and exploited populations. A quantitative approach with an emphasis on mathematical models and their application to population problems. Spring, odd-numbered years. 3 units. *Maguire*

218. Barrier Island Ecology. Adaptation of plants to barrier island migration and other physical characteristics of the coastal environment. Major emphasis will be placed on management of barrier beaches from Maine to Texas and the impact of human interference with natural processes. Field studies. Prerequisite: course in general ecology. Offered at the Duke Marine Laboratory, Beaufort, North Carolina. Summer. C-L: Botany 218 and Marine Sciences 218. 6 units. *Leatherman*

221L. Forest Soils. Introduction to soil resources and the interactions of forest production, management, and soil fertility. Topics include soil chemistry, physics, development, and nutrient cycling, all from the perspective of maintaining and improving forest productivity. Spring, odd-numbered years. 3 units. *Staff*

230. Weather and Climate. 4 units. *Knoerr*

231. Environmental Climatology. Applications of climatology to solving problems in ecology and natural resource management. History of the atmosphere

and world climates is considered to provide a perspective on current conditions. Impact of weather on human behavior, property and natural resource management. Spring. 3 units. *Staff*

232. Microclimatology. Introduction to the microclimatological processes. Discussion of the integration of these processes and the resulting microclimates in the rural (forest, field, and water surface) and urban environments. Methods for modification of the microclimate. Spring, on demand. C-L: Botany 232. 3 units. *Knoerr*

234. Watershed Hydrology. Introduction to the hydrologic cycle with emphasis on the influence of land use, vegetation, soil types, climate, and land forms on water quantity and quality and methods for control. Development of water balance models. Analysis of precipitation patterns, rainfall and runoff, and nonpoint source impacts. Statistical handling and preparation of hydrologic data, simulation and prediction models, introduction to groundwater flow, laboratory and field sampling methods. Fall. 4 units. *Marin*

236. Water Quality Management. 4 units. *Reckhow*

237. Watershed Modeling and Management. Analysis of models for individual hydrologic processes. Evaluation of management-oriented watershed models based on the hydrologic process models. Simulations with watershed models as a basis for management decision making to optimize water yield quantity, timing, or quality under various vegetative, climatic, topographic, and soil conditions. Prerequisite: Forestry and Environmental Studies 234. Spring. 3 units. *Knoerr and Marin*

251. Natural Resource Data Analysis. Elements of statistical inference and estimation including exploratory data analysis, regression, analysis of variance. Fall. 3 units. *Wilkinson*

261. Remote Sensing for Resource Management. An examination of remote sensing systems as sources of information in resource management with an emphasis on aerial photography and multispectral scanners. Emphasis on the interpretation of airborne and space imagery. Spring. 3 units. *Davison*

262. Forest Utilization. Introduction to utilization in the managed forest and the principal wood-using industries. Taught as a one-week field seminar. May be taken by nonforestry majors. Spring. 1 unit, intensive. *Staff*

263. Harvesting and Transportation Systems. Analysis of cable, tractor, and aerial harvesting systems. Sawlog and pulpwood transportation. Emphasis on material flow, inventory control. Application of simulation and optimization methods to harvesting, loading, and transport. Offered on demand. 3 units. *Jayne*

264. Manufacturing Systems. Study of material processing in sawmills, pulpmills, plywood plants, and composite board manufacturing facilities. Emphasis on material flow, quality control, inventory control. Application of quantitative methods and economic analysis to forest product manufacturing operations. Offered on demand. 3 units. *Jayne*

267. Wildland and Wildlife Management. Overview of wildlife management in relation to land use, properties of wildlife populations, elements of game range, manipulation of food and cover, agencies involved in wildlife conservation, and the role of public and political involvement. Spring, on demand. 3 units. *Staff*

268. Resource Management and Business Practices. Presentation of various aspects of managerial accounting and financial analysis crucial to decision making in the management of natural resources. Consideration of corporate financial

statements, sources and uses of funds, breakeven analysis, measurement and projection of business results. Fall. 1 unit, intensive. *MacKinnon*

269. Business Aspects of Natural Resources. Introduction to various business and financial aspects crucial to decision making in the management of natural resources. Specific topics include concepts of managerial accounting, corporate financial statements, measurement and projection of business results, sources of funds and analysis of capital investment decisions, risk and uncertainty in decision making, and survey of computer models used in these areas. Extensive use is made of case studies, problem solving and group discussions. Prerequisite: Forestry and Environmental Studies 270. Fall. 3 units. *MacKinnon*

270. Resource Economics and Policy. The application of economic concepts to private and public sector decision making concerning natural and environmental resources. Investment analysis, benefit-cost analysis. Planning and policy concepts. Prerequisite: introductory course in Economics. C-L: Public Policy Studies 272. Spring. 4 units. *Hyde*

283. Environmental Policy and Values. Discussion of varying philosophical approaches to the allocation and use of natural resources and the environment. Views espoused by ecologists, preservationists, naturalists, conservationists, economists, planners, theologians, lawyers, and political scientists are considered. Through extensive readings, students consider who values what in society, and who gets what, when, and how. Prerequisite: consent of instructor. Fall. 3 units. *Royer*

285. Land Use Principles and Policies. The course will include treatment of the nature of the U.S. land resource base, how rural and urban land uses are determined, land ownership, the role of demand shifts and technological change, and the nature of public policy interventions. Emphasis will be on four major roles of land: as a producer of food, wood, forage, minerals, recreation, and other marketable commodities; as a component of environmental systems; as a financial asset; and as a location for residential, commercial and industrial development. Fall. 3 units. *Healy*

299. Independent Projects. Directed readings or research at the graduate level to meet the needs of individual students. Units to be arranged. *Staff*

301. Forest Nutrition Management. Basic processes of soil chemistry and ecosystem nutrient cycling as regulators of forest production. Management impacts such as fertilization, fire, harvest, and biological nitrogen fixation. Laboratories include methods of determining site fertility, assessing forest productivity, and using computer simulation models to guide management decisions in forest nutrition programs. Spring. 4 units. *Staff*

302. Models in Forestry. Students learn how to develop and choose models for use in forestry decisions, analyze the results, evaluate validity and utility, and interpret models developed by others. Emphasis on silviculture models for timber, wildlife, water, recreation, and cash flow. Fall. 3 units. *Boyce*

305. Harvesting Effects on Productivity. Impacts of harvesting on the residual stand, soil properties, water quality, and future site productivity. The integration of harvesting into overall stand management through a full rotation is stressed. Half course (first half), fall, on demand. 2 units. *Staff*

306. Choices in Silviculture. Simulation of the financial aspects of silvicultural practices when used to produce timber, wildlife habitat, water, range and recreational benefits; economics of production; and trade-offs for multiple benefits. Students use actual forest inventories to devise silvicultural strategies, which are

simulated with the system dynamics models DYNAST and STELLA on microcomputers. Fall. 1 unit. *Boyce and Easterling*

308. Tree Biology. Life processes and properties of trees, including anatomy, physiology, and chemistry. Focuses on the tree as an integrator of ecological site factors in the production of value from the forest. Offered on demand. 2 units. *Staff*

309. Forest Regeneration. Natural and artificial means of creating new forest stands of desirable quality and stocking. Biological, economic, and technical factors are considered. Prerequisite: Forestry and Environmental Sciences 205. Fall, on demand. 2 units. *Staff*

311. Ecological Toxicology. Study of environmental contaminants from a broad perspective encompassing biochemical, ecological, and toxicological principles and methodologies. Discussion of sources, environmental transport and transformation phenomena, accumulation in biota and ecosystems. Impacts at various levels of organization, particularly biochemical and physiological effects. Prerequisites: organic chemistry and vertebrate physiology or consent of instructor. Fall. 3 units. *Di Giulio*

312. Wetlands Ecology. The study of bogs, fens, marshes, and swamps. Emphasis on processes within the ecosystem: biogeochemical cycling, decomposition, hydrology, and primary productivity. Ecosystem structure, the response of these systems to perturbations, and management strategies are discussed. A research project is required. Prerequisites: Forestry and Environmental Studies 211 or equivalent and consent of instructor. Spring, odd-numbered years. 3 units. *Richardson*

314. Integrated Case Studies in Toxicology. Students are assigned topics relative to their chosen research discipline in toxicology and are asked to develop case studies to present at a roundtable workshop. Emphasis on review and analysis of toxicological problems from a holistic (multidisciplinary) viewpoint. C-L: Pharmacology 314. Spring, on demand. 1 unit. *Richardson*

316. Case Studies in Environmental Management. Introduces an integrated ecological, economic, and sociopolitical approach to solving resource management problems. Students work in groups to analyze local problems and present their results. Emphasis on setting goals for research, project organization, selection of quantitative tools, preparation of written and oral presentations. Prerequisites: 211 and 251 or equivalents. Spring. 4 units. *Staff*

318. Seminar in Ecotoxicology. Discussion of current topics concerning environmental contaminants. Individual students review a chosen topic and lead subsequent discussion. Guest speakers. Spring. 1 unit. *Di Giulio*

322. Microbiology of Forest Soils. Ecology of the microbial populations of forest soils, with emphasis on rhizosphere interactions, root pathogenesis, and mycorrhizae. Prerequisite: consent of instructor; mycology and bacteriology are recommended. Spring, odd-numbered years. 4 units, offered on demand. *Stambaugh*

325. Ecologic Effects of Acid Deposition. Impacts on both terrestrial and aquatic ecosystems are examined by reviewing key chemical processes, evaluating case studies, reviewing current literature and research projects, and through discussions with visiting experts. Spring, even-numbered years. 3 units. *Staff*

330L. Environmental Monitoring and Instrumentation. Methods of measuring and monitoring the earth's physical environment with emphasis on water and air resources. Characteristics and uses of contemporary sensors, measurement and data acquisition systems. Methods of obtaining and processing computer

compatible data records. Includes laboratory. C-L: Botany 330L. Spring, on demand. 4 units. *Knoerr*

331. Water Resource Systems. Introduction to the fundamentals of water resource systems planning and management. Emphasis on optimization, simulation, statistical and economic principles for management of surface and subsurface water resources. Topics include project selection and evaluation, design of standards and regulations, stochastic and deterministic quantity/quality simulation models, water supply and wastewater treatment technologies, decision and risk analysis. Spring. 3 units. *Marin*

332. Air Quality Management and Modeling. Types and sources of atmospheric contaminants including effects of industry, urban development, farming and forestry practices, and recreation. Meteorological effects on air quality. Determination of air quality trends and the application of management systems from a meteorological point of view. Types and applications of air quality models. Performance of air quality models under various emission sources, meteorological, and topographic conditions. Fall. 3 units. *Staff*

335. Water Quality Modeling. Development and evaluation of simulation models of surface water quality. Mechanistic description of aquatic ecosystems and materials transport. Parameter estimation, methods of solution, including uncertainty analysis. Prerequisites: Forestry and Environmental Studies 234, 236, 350, 355. Fall, odd-numbered years. 3 units. *Reckhow*

350. Applied Regression Analysis. Regression analysis with nonexperimental data using ordinary least squares. Emphasis on assumption violations: consequences and correctives. Analysis of variance and time series analysis using Box-Jenkins methods as time permits. Prerequisite: Forestry and Environmental Studies 251 or equivalent. Spring. 4 units. *Reckhow*

355. Optimization Methods for Resource Management. Introductory survey of optimization techniques useful in resource management and environmental decision making. Numerical techniques for unconstrained optimization, linear programming, dynamic programming, and optimal control methods. Prerequisite: consent of instructor. Fall. 3 units. *Staff*

357. Systems Ecology and Modeling. Concepts of systems analysis and simulation modeling in ecology. Examples emphasize use of systems analysis and modeling to solve environmental management problems. Prerequisites: ecology, introductory statistics, computer programming on microcomputer and TUCC; additional quantitative background desirable. Spring, even-numbered years. 3 units. *Maguire*

361. Forest Resource Management. The integration of biological, socioeconomic, and environmental constraints in planning, organizing, and managing forest properties for maximizing production of timber and other benefits. Emphasis on analysis of growth and yield for regulation of growing stock; application of economic imperatives in decision making, including valuation of forest land and related resources; and use of microcomputers in simulating management options. Prerequisites: Forestry and Environmental Studies 204, 205. Spring. 4 units. *Parks and MacKinnon*

363. International Trade and Forest Investment. Overview of world trade patterns in both raw and manufactured forest products in the context of international trade theory. International trade and foreign investment policies affecting natural resource based activities. Long- and short-term supply and demand outlooks for the major producing, potentially producing, and consuming nations are considered in terms of natural resource endowment and investment efficiency. International efforts to develop worldwide supply-demand equilibrium models for forest products. Spring. 3 units. *Yoho*

366. Mathematical Modeling of Lake and Reservoir Water Quality. Practical application of mathematical models of lake and reservoir water quality. The major objective is to expose the participant to a wide variety of techniques that are useful in predicting the responses of lakes and impoundments to pollutants. Statistical and mass balance models are included. Knowledge of elementary calculus and statistics is recommended. Fall. 1 unit, intensive. *Chapra and Reckhow*

367. Seminar in Forest Resource Management. Examination of concepts, practices, and policies employed in the management of industrial and public forests; discussion of the problems of large-scale forest management. Offered since 1985-86 as the Laird Norton Distinguished Visitor Series. Spring. 1 unit. *MacKinnon*

370. Economics of Intensive Forestry. Analysis of investments in intensive forestry and comparison of alternative uses of land and capital. Methods commonly used to determine financial returns, financial maturity, present net value, internal rate of return, cash flow, and benefit-cost calculations. Spring. 1 unit, intensive. *Vasievich*

372, 373. Advanced Natural Resource Economics. Survey of advanced topics in natural resource and environmental economics. Emphasis on renewable resources and public policy. Prerequisite: consent of instructor. Fall and spring. 3 units each. *Hyde*

381. Natural Resource Policy. An examination of institutions and processes in the public sector that influence natural resource allocation and use of the environment. Emphasis on political allocation of resources, especially legislative and administrative processes. Topics include the rules of democracy and free enterprise, lobbying, public participation, planning, and advocacy. Prerequisite: consent of instructor. Spring. 3 units. *Royer*

383. Natural Resources Conflict Management. Current issues in the natural resources field and methods of solution, including conflict avoidance, joint planning, mediation, conciliation, public participation, and consensus building. Spring. 1 unit, intensive. *Busterud*

384. Special Tax Problems for Industrial Timberland Owners. Current problems of industrial timber taxation including the use of subsidiaries in sales, Internal Revenue Service audits, valuation, financing of land, and casualties. Prerequisite: Forestry and Environmental Studies 288 or equivalent experience. Fall. 1 unit, intensive. *Condrell*

385. Decision Theory and Risk Analysis. Bayesian decision theory, including conditional probability, subjective probability, utility theory, value of sample information, and multiattribute problems. Behavioral decision theory. Applications of decision theory in resource and environmental policy making. Prerequisite: Forestry and Environmental Studies 251 or equivalent. Spring, even-numbered years. 3 units. *Maguire and Reckhow*

386. Problem Solving Processes and Management Concepts: the Individual and the Team. Course designed to improve the management skills of the participants. Emphasis on identification of problem type (planning problem, decision problem, or cause and effect analysis) and application of appropriate solution processes. Focus on participatory management, communication skills, and time management—stress management concepts. Fall. 1 unit, intensive. *Banzhaf*

388. Seminar in Resource and Environmental Policy. Discussion of the political, legal, and socioeconomic aspects of public and private action in environmental quality control and management. Prerequisite: consent of instructor. Fall, spring. 1 unit. *Staff*

389. Seminar in Forest and Conservation History. Evolution of resource agencies, forest industries and associations, and conservation/environmental organizations. Public policies for land and resources are compared with priorities and constraints in the private sector. Prerequisite: consent of instructor. Spring, odd-numbered years. 2 units. *Steen*

COURSES CURRENTLY UNSCHEDULED

209. Forest Entomology

310. Forest Productivity and Mineral Cycling

338. Micrometeorology and Biometeorology Seminar

The University Program in Genetics

Professor Antonovics, *Director* (botany); Professors Amos (microbiology and immunology), Bastia (microbiology and immunology), Boynton (botany), Counce (anatomy), Gillham (zoology), Gross (biochemistry), Guild (biochemistry), Holmes (medicine and biochemistry), Joklik (microbiology and immunology), Kredich (biochemistry), Modrich (biochemistry), Moses (anatomy), Nicklas (zoology), C. Ward (zoology), F. Ward (microbiology and immunology), and Webster (biochemistry); Associate Professors Endow (microbiology and immunology), Greene (biochemistry), Greenleaf (biochemistry), M. Hershfield (biochemistry), Hsieh (biochemistry), Keene (microbiology and immunology), Linney (microbiology and immunology), Rausher (zoology), Ruderman (zoology), Steege (biochemistry), and Uyenoyama (zoology); Assistant Professors Burdett (microbiology and immunology), Johnston (botany), Kaufman (biochemistry), Kreuzer (microbiology and immunology), Ostrowski (microbiology and immunology), and Schachat (anatomy); Adjunct Professors Drake (National Institute of Environmental Health Sciences), Judd (National Institute of Environmental Health Sciences), Kunkel (National Institute of Environmental Health Sciences), Lucchesi (University of North Carolina), Resnick (National Institute of Environmental Health Sciences), and Sugino (National Institute of Environmental Health Sciences)

The University Program in Genetics provides a coherent course of study in all facets of biology related to genetics. Graduate students registered in any of the biological sciences departments may apply to the faculty of the genetics program to pursue study and research leading to an advanced degree. It would be helpful if applicants for admission to the Graduate School indicated their interest in the genetics program at the time of application. Requests for information describing more completely the research interests of the staff, facilities, and special stipends and fellowships should be addressed to the Director, Genetics Program (Department of Botany).

For Seniors and Graduates

205. Genetic Engineering. Molecular aspects of gene expression and cell differentiation; application of recombinant DNA techniques to basic and applied problems. Prerequisites: organic chemistry and cell biology or genetics. C-L: Botany 205. 3 units. *Johnston*

215. Molecular Genetics I: Genetic Mechanisms. Genetic mechanisms in molecular terms emphasizing gene function, segregation, and regulation in procaryotes and eucaryotes. Systems covered include bacterial viruses, bacteria, plasmids, cellular organelles, and selected lower and higher eucaryotes. Course material will be drawn from the original literature. Prerequisite: introductory biochemistry. C-L: Biochemistry 215. 3 units. *Webster and staff*

268. Molecular Biology II: Nucleic Acids. Structure and metabolism of nucleic acids in the context of their biological function in information transfer. Prerequisites: introductory biochemistry and Molecular Biology I or consent of instructor. C-L: Biochemistry 268, Botany 268, and Microbiology and Immunology 268. 4 units. *Modrich and staff*

280. Principles of Genetics. Structure and properties of genes and chromosomes in individual organisms and in populations. Prerequisites: introductory biology. C-L: Botany 280 and Zoology 280. 3 units. *Antonovics, Boynton, and Gillham*

283. Extrachromosomal Inheritance. Genetics, biochemistry, and molecular biology of the organelles of eukaryotic cells, and cellular symbionts. Prerequisite: introductory genetics. C-L: Botany 283 and Zoology 283. 3 units. *Boynton and Gillham*

285S. Ecological Genetics. Interaction of genetics and ecology and its importance in explaining the evolution, diversity, and distribution of plants and animals. Prerequisites: Botany 280 and 286 or equivalents. C-L: Botany 285S. 3 units. *Antonovics*

286. Evolutionary Mechanisms. Population ecology and population genetics of plants and animals. Fitness concepts, life history evolution, mating systems, genetic divergence, and causes and maintenance of genetic diversity. Complements Zoology 235. Prerequisites: college biology and Genetics 280 or equivalent. C-L: Botany 286 and Zoology 286. 3 units. *Antonovics and H. Wilbur*

288. Mathematical Population Genetics. Principles of formulation and analysis of dynamic mathematical models of genetic evolution. Rotating topics include: mating systems, sex ratio, stochastic processes. Prerequisite: calculus; statistics and linear algebra recommended. C-L: Zoology 288. 3 units. *Uyenoyama*

For Graduates

336. Contemporary Topics in Immunogenetics. Selected themes in immunogenetics with special emphasis on molecular approaches. The major areas discussed are: the nature, interaction, and expression of immunoglobulin genes and T-cell receptor genes, the genes of the major histocompatibility complex, and the genes of the T/t complex. The central ideas discussed include the manner in which cells recognize and interact with each other in phylogeny, ontogeny, and in differentiation; how gene families evolve and interact; and how information about these complex genetic systems is used in basic research and in clinical medicine. Prerequisite: Microbiology and Immunology 244 or 291 or 330 or equivalent. C-L: Microbiology and Immunology 336. 2 units. *Amos, Ward, and staff*

350. Genetics Colloquium. Lectures, discussion sessions, and seminars on selected topics of current interest in genetics. Required of all students specializing in genetics. Prerequisites: a course in genetics and consent of instructor. 1 unit. *Antonovics and staff*

Geology

Professor Perkins, *Chairman* (204 Old Chemistry); Professor Heron, *Director of Graduate Studies* (205 Old Chemistry); Professor Pilkey; Associate Professors Corliss, Johnson, Karson, and Rosendahl; Assistant Professors Baker, Bloomer, and Strelitz

The Department of Geology offers graduate work leading to the M.S. and Ph.D. degrees. An undergraduate degree in geology is not a prerequisite for graduate studies, but a student must have had or must take a summer field geology course (or equivalent experience), mineralogy, igneous and metamorphic rocks, stratigraphy or sedimentation, and structural geology. In addition, the

student must have had one year of college chemistry, one year of college physics, and mathematics through calculus.

Graduate courses and research in the Department of Geology provide specialized training in the fields of facies analysis, sedimentary petrology, geological oceanography and limnology, coastal geology, micropaleontology, geophysics, low-temperature geochemistry, igneous petrology, high-temperature geochemistry, and structural geology and tectonics. An acceptable thesis is required. There is no language requirement for the M.S. degree.

For Seniors and Graduates

200. Beach and Coastal Processes. The study of sedimentary processes, and geomorphology of nearshore environments with emphasis on both developed and undeveloped barrier island systems. 3 units. *Pilkey*

203. Physical Oceanography. Physical processes in the oceans: the physical properties of seawater, the dynamics of currents, waves and tides, and the transmission of light and sound in the sea. Prerequisite: Physics 41 or 51. (Given at Duke Marine Lab, Beaufort.) C-L: Marine Sciences 203. Half course. *Johnson*

204. Chemical Oceanography. Chemical processes in the oceans: the major ion composition of sea salt, the distribution of dissolved gasses in seawater, sediment-seawater interactions, and seawater-basalt interactions at oceanic ridge crests. Prerequisites: Chemistry 11 and Geology 203 (may be taken concurrently). (Given at Duke Marine Lab, Beaufort.) 3 units. *Staff*

205S. Geological Oceanography. The geology of ocean basins, including origin, bottom physiography, sediment distribution, and sedimentary processes. Not open to students who have taken Geology 206S. (Given at Duke Marine Lab, Beaufort.) C-L: Marine Sciences 205S. 3 units. *Johnson*

206S. Principles of Geological Oceanography. Geological aspects of the ocean basins including coastal to deep water sediment types and sedimentation processes, sea floor physiography and environmental problems. 3 units. *Pilkey*

208S. Paleoceanography. Application of stratigraphic, paleontologic, and geochemical evidence in sediments to understanding ancient oceans and climates. Prerequisite: Geology 206S or consent of instructor. 3 units. *Baker*

209S. Marine Sediments. Sedimentary processes in nearshore, shelf, and deep-sea environments. Emphasis on field methods and laboratory analyses. (Given at Beaufort.) C-L: Marine Sciences. 3 units. *Johnson*

212. Carbonate Facies Analysis: Recent and Ancient. Origin, distribution, and diagenetic alteration of recent carbonate sediments and their ancient analogs. Prerequisite: Geology 111. 3 units. *Perkins*

214S. Sedimentary Petrography. Descriptive and interpretive analysis of sediments and sedimentary rocks in thin section, with an emphasis on diagenesis. Prerequisite: consent of instructor. 3 units. *Perkins*

215. Clastics Facies Analysis: Recent and Ancient. Modern clastic depositional systems and their ancient analogs. Prerequisite: Geology 111. 3 units. *Heron*

216. Field Analysis of South Florida Carbonates. Analysis of recent sediments and organisms and their Pleistocene analogs. One-week field trip. Prerequisite: Geology 111 or consent of instructor. 1 unit. *Perkins*

217. Field Analysis of Ancient Sedimentary Sequences. Regional analysis of ancient clastic and carbonate systems. One-week field trip. Prerequisite: Geology 111 or consent of instructor. 1 unit. *Heron or Perkins*

230S. Advanced Topics in Structural Geology and Tectonics. Selected topics related to the deformation of rocks, ranging from microstructure to plate tectonics. Prerequisite: Geology 130 or consent of instructor. 3 units. *Karson*

249. Marine Micropaleontology. Introduction to marine microfossils, basic principles of micropaleontology and stable isotope geochemistry with applications to paleoceanography. Lectures and laboratory. Prerequisite: Geology 206S or consent of instructor. 3 units. *Corliss*

251. Physics of the Earth. Origin, primeval evolution, rotation, potential fields, paleomagnetism, gravity anomalies, earthquake seismology, thermal properties, internal structure of the earth, and thermodynamics of plate motions. Prerequisites: Geology 41 and Chemistry 12 and Mathematics 32 and Physics 52 or consent of instructor. 3 units. *Rosendahl*

252. Exploration Seismology. Elastic wave theory, reflection and refraction of acoustic waves, field methodologies, computer processing, and interpretation of seismic data. Prerequisites: Geology 41 and Mathematics 32 and Computer Science 51 and Physics 52 or consent of instructor. 3 units. *Rosendahl*

255. Seismic Interpretation. Basic rock physics, seismic expression of structural styles, seismic facies analysis, maps generated from seismic data, and basin-wide seismic stratigraphic analysis. Prerequisite: Geology 251; corequisite: Geology 252 or consent of instructor. 3 units. *Rosendahl and staff*

260S. Hydrocarbon Exploration. Origin, migration, and accumulation of hydrocarbons with emphasis on exploration techniques. Prerequisites: Geology 111 and 251. 3 units. *Perkins and Rosendahl*

270. Geochemistry. Application of chemical principles to geological problems. Prerequisites: Chemistry 12 and Mathematics 32. 3 units. *Baker*

271. Low-Temperature Geochemistry. Chemistry of aqueous solutions, authigenic minerals, surfaces, and stable isotopes in sedimentary systems. Prerequisite: Geology 270 or consent of instructor. 3 units. *Baker*

272. Biogeochemistry. Processes controlling the circulation of carbon and biochemical elements in natural ecosystems and at the global level, with emphasis on soil and surficial processes. Prerequisite: Chemistry 12, Botany 146L, or equivalent. C-L: Botany 272. 3 units. *Schlesinger*

281S. Advanced Topics in Igneous Petrology. Current topics in igneous petrology including andesite petrogenesis, ocean ridge basalts, and experimental petrology. Prerequisites: Geology 105 and 106. 3 units. *Bloomer*

283S. Experimental Methods in Geology. Theory and application of experimental techniques in igneous and metamorphic petrology and high- and low-temperature geochemistry, with examples from recent literature. Prerequisites: Geology 105 and 106 or consent of instructor. 3 credits. *Bloomer*

292. Computer Methods in Geology. Techniques used in the geological sciences including simulation and forward modelling, inverse and least squares methods, statistical methods and exploratory data analysis as well as graphics. Prerequisites: Mathematics 32 and Computer Science 51, or consent of instructor. 3 units. *Strelitz*

295S. Advanced Topics in Geology. Topics, instructors, and credits to be arranged each semester. *Staff*

For Graduates

371, 372. Advanced Topics in Geology. To meet the individual needs of graduate students for independent study in various environmental sedimentary fields. 1 to 3 units. *Staff*

COURSES CURRENTLY UNSCHEDULED

    253S. Geophysics

    254. Geophysical Field Methods

Germanic Languages and Literature

Associate Professor Borchardt, *Chairman*; Associate Professor Rolleston, *Acting Director of Graduate Studies* (106 Languages); Associate Professor Alt; Assistant Professor Morton; Visiting Professor Jantz

The Department of Germanic Languages and Literature offers graduate work leading to the A.M. degree. Students who expect to major in German should have had sufficient undergraduate courses in Germanic languages to enable them to proceed to more advanced work.

Students who wish to take courses in German as a related field should normally have completed a third-year course (in exceptional cases, a second year) of college German with acceptable grades.

For Seniors and Graduates

200S. Proseminar. Fundamental course for advanced study of German; literary history, schools of criticism, practical exercises in interpretation, and research methods. 3 units. *Alt*

201S, 202S. Goethe. His life and works, in the light of his lasting significance to Germany and world literature. 201S: lyrics, prose, fiction, and selected dramas. 202S: *Faust I and II*. 3 units each. *Jantz or Morton*

205, 206. Middle High German. The language and literature of Germany's first classical period. C-L: Medieval and Renaissance Studies. 3 units each. *Staff*

207S. German Romanticism. The principal writers of the period from 1795 to 1830. 3 units. *Alt or Rolleston*

209S. Drama. Studies in the German-speaking theater with emphasis on the nineteenth century. 3 units. *Alt*

210S. The Eighteenth Century. The culture of reason, progress, and the individual in early modern philosophy and literature. Leibniz, Lessing, Herder, Kant, Schiller. 3 units. *Morton*

211S. Nineteenth-Century Literature. From the end of Romanticism through Realism. 3 units. *Alt*

214S. The Twentieth Century. Literature of the twentieth century presented through representative authors. 3 units. *Rolleston*

215S. Seventeenth-Century Literature. Leading writers of the baroque, viewed against the background of their time. C-L: Medieval and Renaissance Studies. 3 units. *Borchardt*

216. History of the German Language. Development of the phonology, morphology, and syntax of German from the beginnings to the present. C-L: Linguistics and Medieval and Renaissance Studies. 3 units. *Staff*

217S. Renaissance and Reformation Literature. The period from 1400 to about 1600. C-L: Medieval and Renaissance Studies. 3 units. *Borchardt*

218S. The Teaching of German. A survey of modern teaching techniques: problems in the teaching of German on the secondary and college levels. Analysis and valuation of textbooks and related audiovisual materials. 3 units. *Alt*

219. Applied Linguistics. The application of modern linguistic principles to a systematic study of the phonetics, morphology, and syntax of modern German. C-L: Linguistics. Prerequisite: consent of instructor. 3 units. *Staff*

230S. Lyric Poetry. Studies in poetry and poetic theory. From Goethe and the romantics to Rilke, Benn, and contemporary authors. 3 units. *Rolleston*

COURSES CURRENTLY UNSCHEDULED

321, 322. Germanic Seminar

Health Administration

Professor McMahon, *Chairman*; Associate Professor Taylor, *Director of Graduate Studies*; Professors Jaeger and Warren; Associate Professor Falcone; Assistant Professors Martin and Smith; Adjunct Associate Professor Winfree; Adjunct Assistant Professors Donelan, Moore, Veit, and Yaggy

The Department of Health Administration offers graduate work leading to the M.H.A. degree. The graduate program is offered through two academic years and leads principally toward a career in the corporate management of hospitals and other health services organizations. Students without previous administrative experience in the health field are encouraged to apply for a twelve-month administrative fellowship following graduation. Admission to the program is based upon the capability for graduate study and demonstrated leadership potential of the candidate.

301. Health System and the Environment. Introduction to the organizational and professional systems which provide health care services, including past, present, and future perspectives and relationships among institutions, professionals, government, and the private sector. Emphasis is on the changing and dynamic nature of the health care environment and resulting system responses. 3 units. *Staff*

302. Organizational Behavior in Health Systems. This course will consider the leadership roles of the manager and his or her responsibility for maintaining a productive organization in a changing economic environment. It will develop models for considering consequences of the interaction of members of the organization with changing technology and other externalities, and will examine how appropriate leadership behavior frequently determines the success or failure of an institution. 3 units. *Taylor*

303-304. Health Systems and the Environment—Laboratory. A laboratory course to facilitate familiarity with the operation of health facilities and the appreciation of the challenge of planning, organizing, financing, staffing, controlling, and evaluating the provision of health care services. (To be taken concurrently with Health Administration 301 and 302.) 1 unit each. *McMahon*

311-312. Leadership Seminar. Designed as the integrating course of the program, this two-semester seminar provides a forum for ongoing interaction among student/faculty/practitioners in the context of exploring the concepts and implementation of strategies for both causing and responding to the dynamics of change in health organizations. 1 unit each. *McMahon*

321-322. Strategic Planning for Health Services. A comprehensive, two-semester course which applies and extends courses taken in the Fuqua School and draws upon several disciplinary areas in order to develop a conceptual and operational basis for management control over designing, planning, allocating, utilizing, and evaluating resources used in providing health services. 3 units each. *Staff*

325. Health Law for Management. Introduction to law and the legal approach to problem solving in health care; provides background for understanding the role of law and legal institutions in affecting access, availability, cost, quality, and evaluation of health care services. 3 units. *Warren*

327. Financial Management for Health Care Organizations. Provides a comprehensive overview of both short-run and long-term issues in health care financial management. Topics include cash management, collection and disbursement techniques, cash forecasting, short-run financial planning, receivables management, capital budgeting under uncertainty, dividend policy, and capital structure decisions. 3 units. *Taylor*

331. Human Resources Management. Course focuses on the responsibilities and role of all managers and supervisors in regard to human resource management, the issues in developing a proactive human resource planning model with an adaptable framework, and strategies for responding to events, trends, and issues affecting human resources. 3 units. *Staff*

341, 342. Advanced Seminar in Health Care Institutional Management. An integrating sequence of case studies in institutional and programmatic settings designed to provide students the opportunity to study actual problems and to propose solutions in the classroom setting. 3 units each. *Smith*

343. Comparative Health Systems. Against the backdrop of the United States health system, including the Veterans Administration system, the course examines the potential for innovation and common problems in health services delivery from an international perspective. 3 units. *Falcone*

352. Health Services for the Aged. Covers socioeconomic, cultural, and demographic trends affecting health and medical care for older persons; political and legal developments; health care facilities and alternatives to institutionalization; geriatrics and gerontology for the administrator. 3 units. *Falcone and Warren*

354. Quality Assurance, Risk Management, and Liability Insurance. A seminar to acquaint students with the theory and concepts of coordinated quality assurance and risk management in health care organizations. Attention is given to the steps involved in designing and implementing an effective QA/RM program and various insurance mechanisms. 3 units. *Moore and Warren*

356. Health Policy Analysis. The major purpose is to broaden and enrich students' perspectives on the health system through an examination of policy determinants, with a focus on political system variables, structures, and processes, against the backdrop of environmental constraints. 3 units. *Falcone and Warren*

358. Cost Benefit Analysis. Demonstrates the utility of logical modes in management and planning decisions. Since this logic is usually quantifiable within limits, the course reviews problem conceptualization, methodology, and techniques for determining the costs, benefits, effectiveness, and efficacy of decisions regarding optimal deployment of resources. 3 units. *Falcone*

362. Planning and Managing Alternative Delivery Systems. This course is designed to examine the current state of development of alternative delivery systems (health maintenance organizations, preferred provider organizations, competitive medical plans and other mechanisms to control costs by changing provider incentives) and to explore likely future directions such systems will take. 3 units. *McMahon*

371, 372. Directed Research. Individual studies and health services projects by arrangement. 3 units each. *Staff*

History

Professor Warren Lerner, *Chairman* (235 Allen); Professor Mauskopf, *Director of Graduate Studies* (233A Allen); Professors Bergquist, Cahow, Cell, Chafe, Colton, C. Davis, Durden, Holley, Oates, Richards, A. Scott, W. Scott, TePaske, Witt, and Young; Associate Professors Dirlik, Gaspar, Gavins, Goodwyn, Kuniholm, Miller, Nathans, Roland, and Wood; Assistant Professors Robisheaux, R. Davis, English, Ewald, Gordon, Herrup, Keyssar, Neuschel, and Reddy; Professors Emeriti Ferguson, Franklin, Parker, Preston, Ropp, and Watson

The Department of History offers graduate work leading to the A.M. and Ph.D. degrees. Candidates for the A.M. degree must have a reading knowledge of at least one ancient or modern foreign language related to their programs of study and have completed successfully a substantial research paper, or two seminar papers, normally the product of a year's seminar or two semester courses. The paper(s) must be approved by two readers, the supervising professor and a second professor from the graduate staff. Students anticipating a May degree must have their papers read and approved by April 15; those anticipating a September degree must have their papers read and approved by August 1.

Candidates for the degree of Doctor of Philosophy prepare themselves for examinations in four fields, at least three of which shall be in history. The choice of fields is determined in consultation with the student's supervisor and the Director of Graduate Studies. The department offers graduate instruction in the fields of Africa, Afro-American history, ancient history, medieval and early modern Europe, modern Europe, American history, Britain and the Commonwealth, Imperial Russia, Soviet Russia, Latin America, South Asia, China, modern Japan, military history, history of science, and history of medicine. The candidate for the Ph.D. degree must have a reading knowledge of two foreign languages to be picked in conjunction with the candidate's supervisor. In certain cases, an alternative to the second language may be chosen if approved by both the candidate's supervisor and the Director of Graduate Studies. Such an alternative must take the form of successful completion of a course or courses which would appreciably increase the candidate's methodological proficiency; such as a graduate course in statistics, archaeology, demography, numismatics, cartography, or a summer training program for developing methodological skills. A course or courses in a discipline outside history—anthropology, literature, sociology, political science, ecology, geography, etc.—will not necessarily qualify as an alternative to a second language. Also, the alternative must be in addition to any previous undergraduate work in the methodology. Whether satisfied by two languages or by one language and an alternative, the requirement must be met prior to the preliminary examination.

Ancient History. For courses in ancient history which may be taken for credit in either history or classical studies, see Classical Studies.

For Seniors and Graduates

Students may receive credit for either semester of a hyphenated course at the 200 level without taking the other semester if they obtain written consent from the instructor.

201S. The Russian Intelligentsia and the Origins of the Revolution. Origin and dynamics of the Russian revolutionary movement, the intelligentsia, and the emergence of the labor movement. 3 units. *Miller*

202S. The Russian Revolution. An analysis of the conflicting secondary interpretations of the revolution and of the major social forces responsible for the revolutions of 1917 using primary materials. 3 units. *Miller*

207, 208. Constitutional History of Britain: The Rise of the Common Law. The origins and development of Britain's law and constitution, related to its setting in a changing society. C-L: Comparative Area Studies and for 207: Medieval and Renaissance Studies. 3 units each. *Herrup*

215-216. The Diplomatic History of the United States. (Not open to undergraduates who have had History 121, 122.) 6 units. *Davis*

217S, 218S. Western Europe in the Twentieth Century. Topics in political and social history: Europe in 1900; the impact of two world wars; the social politics of the great depression; fascism and nazism; economic recovery and changes after 1945. 3 units each. *Colton*

219S, 220S. History of Science and Technology. The interaction of science and technology in the Western world from earliest times to the present. 3 units each. *Mauskopf and Roland*

221. Problems in the Economic and Social History of Europe, 1200-1700. C-L: Medieval and Renaissance Studies. 3 units. *Witt*

222. Problems in the Intellectual History of the European Renaissance and Reformation. Prerequisites: History 194 and reading knowledge of German, French, or Italian. C-L: Medieval and Renaissance Studies. 3 units. *Witt*

227-228. Recent United States History: Major Political and Social Movements. C-L: Women's Studies. 6 units. *Chafe*

229S, 230S. Revolution in Modern Europe, 1789-1919. The French Revolution, the revolutions of 1830 and 1848, the Paris Commune, and the Russian and German revolutions of 1917 and 1918-1919. Emphasis on the evolution of historians' efforts at explanation of revolutions and on the relationship between social and political change. 3 units each. *Reddy*

231S, 232S. Problems in the History of Spain and the Spanish Empire. 3 units each. *TePaske*

233. Slave Resistance and Social Control in New World Societies. The operation of slave societies in the Americas from the sixteenth to the nineteenth centuries focusing on master-slave relations and slave resistance. 3 units. *Gaspar*

234S. Political Economy of Development: Theories of Change in the Third World. C-L: Anthropology 234S, Political Science 234S, and Sociology 234S. 3 units. *Bergquist, Fox, Gereffi, Smith, and Valenzuela*

237S. Europe in the Early Middle Ages. C-L: Medieval and Renaissance Studies. 3 units. *Young*

238S. Europe in the High Middle Ages. C-L: Medieval and Renaissance Studies. 3 units. *Young*

239S. History of Socialism and Communism. Problems in the origins and development of socialist and communist movements. 3 units. *Lerner*

241-242. United States Constitutional History. 241: to 1865; 242: 1865 to the present. 6 units. *Cahow*

243-244. Marxism and History. 6 units. *Dirlik*

245, 246. Social and Intellectual History of China. 3 units each. *R. Davis and Dirlik*

247. History of Modern India and Pakistan, 1707-1857. Analysis and interpretation, with special emphasis on social and economic change. 3 units. *Richards*

248. History of Modern India and Pakistan, 1857 to the Present. 3 units. *Richards*

249-250. Social and Intellectual History of the United States. The interplay of ideas and social practice through the examination of attitudes and institutions in such fields as science and technology, law, learning, and religion. 6 units. *Holley*

253S, 254S. European Diplomatic History, 1871-1945. Origins of the First and Second World Wars, the diplomacy of the wars, and the peace settlements which followed them. 3 units each. *W. Scott*

259. Archaic Greece. See C-L: Classical Studies 221. 3 units. *Oates or Rigsby*

262. Problems in Soviet History. Studies in the background of the Revolution of 1917 and the history and politics of the Soviet state. 3 units. *Lerner*

265S. Problems in Modern Latin American History. 3 units. *Bergquist*

266. Late Antiquity. See C-L: Classical Studies 226. 3 units. *Rigsby*

269S-270S. British History, Seventeenth Century to the Present. Historiography of social structure and social change: English Revolution, party, the Industrial Revolution, class and class consciousness, Victorianism, and the impact of war in the twentieth century. 6 units. *Cell*

273S, 274S. Topics in the History of Science. Critical stages in the evolution of scientific thought. 3 units each. *Mauskopf*

277S. The Coming of the Civil War in the United States, 1820-1861. 3 units. *Durden*

278S. The Civil War in the United States and Its Aftermath, 1861-1900. 3 units. *Durden*

279, 280. Health, Healing, and History. The development of medicine within the broader cultural context from prehistory to the twentieth century. Not open to students who have had History 181, 182. 3 units each. *English*

282S. Canada. C-L: Anthropology 282S, Political Science 282S, and Sociology 282S. 3 units. *Leach*

284S. Feminist Theory and the Social Sciences. Examination of feminist modes of inquiry in the social sciences. The relationship of gender in economic, political, social, and cultural systems and the resulting shifts in social science disciplines. C-L: Interdisciplinary Course 284S. 3 units. *Chafe, Neuschel, O'Rand, or C. Smith*

285S, 286S. Oral History. Research on race relations and civil rights in the United States in the twentieth century using techniques of oral history. 3 units each. *Chafe and Goodwyn*

Required Courses for Graduates

301-302. Research Seminar in History. Either this seminar or History 307-308 is required of all entering first-year doctoral candidates in history. 6 units. *Staff*

307-308. Seminar in United States History. Either this seminar or History 301-302 is required of all entering first-year doctoral candidates in history. 6 units. *Staff*

312. Seminar in the Teaching of History in College. The work in this course is intended to acquaint students with the problems involved in teaching history in college. Required of all candidates for the degree of Doctor of Philosophy who are in residence for two years at Duke. As an alternate method of meeting this requirement, a graduate student may, in cooperation with a member of the faculty,

serve a one-semester teaching apprenticeship. No credit. Supervised by Director of Graduate Studies.

314. Historical and Social Science Methodology. Methods used in historical research with emphasis upon the various social science approaches. 3 units. *Wood*

History 314 is required of all candidates for the Ph.D. degree who are in residence for two years at Duke University.

Colloquia and Seminars for Graduates

351-352. Colloquia. Each colloquium deals with an aspect of history by means of readings, oral and written reports, and discussion, with attention to bibliography. Ad hoc colloquia may be worked out during registration in the various fields represented by members of the graduate faculty; these colloquia do not appear on the official schedule of courses. In some instances, students may take the equivalent of a research seminar in conjunction with the colloquium and will be credited with an additional 6 units by registering for 371.1-372.1, etc.

371-372. Research Seminars. To be taken either in conjunction with colloquia listed above or by special arrangement with appropriate graduate instructors when research seminars in a desired area are not offered. These seminars do not appear on the official schedule of courses. 6 units. *Staff*

Independent Study

399. Supervised independent study and reading, with consent of professor. 3 units.

N.B. For the most current listing of scheduled courses, please refer to the most recent Duke University official schedule of courses printed twice a year.

The Master of Arts Program in Humanities

Professor Young, *Director* (history)

The Master of Arts Program in Humanities is an interdepartmental program and is tailored to the needs of individual students. The candidate defines a theme and selects appropriate course work with the aid and approval of a supervising committee. Thirty units of course work and proficiency in a foreign language are required for completion of the program. The degree may be earned with or without a thesis. The candidate who chooses not to submit a thesis will submit instead at least two substantial papers arising from course work for review by committee members, and meets with them to discuss his or her program in a final master's colloquium.

The program is open to holders of undergraduate degrees in any discipline who can demonstrate sufficient background in humanities to permit study at the graduate level. Admission is by regular application to the Graduate School. Students may enroll full time or part time (minimum of 3 units per term). Students considering entering the program may enroll in an appropriate graduate course or courses through the Office of Continuing Education, at the same time making their interest known to the Director of the Humanities Program.

The Master of Arts Program in Liberal Studies

This interdisciplinary program allows individuals with a variety of professional and personal educational interests the flexibility to pursue their interests across traditional disciplinary boundaries. The program is managed by an interdepartmental committee which advises students and directs their course of study.

Students study primarily on a part-time basis and choose from an array of interdisciplinary courses developed specifically for this program. In addition to the special liberal studies courses, students select other graduate-level courses that fit their individual needs and interests.

The MALS program consists of nine courses and a final project. These courses are offered during three academic terms (fall, spring, and summer) and may be taken either full-time or part-time. For more information on specific courses and other program requirements, a separate bulletin on the Master of Arts in Liberal Studies may be requested from the program director (122 Allen Building, Duke University, Durham, North Carolina 27706).

350. Final Project Colloquium. 3 units. *Staff*

The Ph.D. Program in Literature

Professor Jameson *Chairman* (Graduate Program in Literature); Associate Professor Rolleston, *Director of Graduate Studies* (Germanic Languages and Literature); Professors Arac (Graduate Program in Literature), Fish (English and Law), Herrnstein Smith (Graduate Program in Literature and English), Lentricchia (English), A. Patterson (Graduate Program in Literature and English), Stewart (French), and Tompkins (English); Associate Professors DeNeef (English), Pérez Firmat (Spanish), and Thomas (French)

The interdepartmental program leading to a Ph.D. in literature offers to qualified students the opportunity to develop individual courses of study with a strong emphasis on interdisciplinary work, literary theory, and cultural studies, while at the same time building strength in one or more of the national literatures. The program offers both core courses (the 250 series) and more specialized seminars (the 280 series), as well as tutorials (300) in specific research projects or problems.

For tutorials, advising, and dissertation supervision the program draws also on the expertise of other faculty, such as Professors Herington, Newton, and Associate Professor Burian (Classical Studies); Professor Tetel and Associate Professor Orr (French); Professor Wardropper (Spanish); Professor Borchardt (German); Professors Ryals and L. Patterson (English).

Students entering the program must present evidence of ability to read one language other than English, and must acquire reading competence in a second language before taking their preliminary examinations.

More information on the program and a full descriptive brochure is available from Professor Rolleston, Director of Graduate Studies, 104 Languages Building, Duke University, Durham, North Carolina 27706.

251. History of Criticism. A historical survey of critical and philosophical concepts affecting the definition and evaluation of literature from Plato and Aristotle through the nineteenth century. 3 units. *Arac, DeNeef, Lentricchia, or Pérez Firmat*

252. Criticism and Literary Theory in the Twentieth Century. Introduction to critical movements, philosophies, and strategies informing contemporary theories of literature: deconstruction, feminism, formalism, Marxism, New Criticism, phenomenology, psychoanalysis, structuralism. 3 units. *Rolleston, with guest lecturers*

253. Philology, Linguistics, and the Roots of Literature. A survey of the various ways in which language and literature interact, with an introduction to philology and historical linguistics. 3 units. *Thomas*

(The 280-290 series implies prior knowledge of literary theory, past and present; these courses are open to graduate students and qualified seniors only.)

281. Paradigms of Modern Thought. Specialized study of the work of individual thinkers who have modified our conceptions of human reality and social and cultural history, with special emphasis on the form and linguistic structures of their texts considered as "language experiments." Topics will vary from year to year, including: Marx and Freud; J.-P. Sartre; Walter Benjamin; etc. 3 units. *Jameson*

282. Contemporary Literary Theory. Specialized studies in literary theory from Saussurean linguistics to the present day (e.g., deconstruction, feminism, new historicism, neopragmatism, reception theory). 3 units. *Arac, Fish, Jameson, Lentricchia, Patterson, or Tompkins*

283. Modernism. Aspects of the "modern," sometimes with emphasis on the formal analysis of specific literary and nonliterary texts (Joyce, Kafka, Mahler, Eisenstein); sometimes with a focus on theories of modernism (Adorno), or on the modernism/postmodernism debate, or on the sociological and technological dimensions of the modern in its relations to modernization, etc. 3 units. *Arac, Jameson, or Lentricchia*

284. The Intellectual as Writer. History and theory of the literary role of the intellectual in society (e.g., in Augustan Rome, the late middle ages, the Renaissance, America, Latin America). 3 units. *Lentricchia or Patterson*

285. Literature and Ideology. The theoretical problem of the relationship between literature and ideology, explored through the cultural history of genres, major writers, or aesthetic movements. 3 units. *Jameson, Lentricchia, or Patterson*

286. Topics in Legal Theory. A consideration of those points at which literary and legal theory intersect (e.g., matters of intention, the sources of authority, the emergence of professional obligation). 3 units. *Fish*

287. Problems in Narrative Analysis. An introduction to contemporary theories and methods of narrative analysis (Greimas, Barthes, Hayden White, etc.), with emphasis on a specific area, e.g., historiography, film, sub-genres of the novel, cognitive discourse. 3 units. *Jameson*

288. Basic Issues in the History of Literary Theory. Issues include attempts to define literature, divergent views of its social functions and psychological effects, and contemporary controversies regarding literary meaning and interpretation. Readings range from classic texts in philosophy of art to contemporary essays in critical theory. 3 units. *H. Smith*

289. Topics in Feminist Theory. 3 units. *Staff*

290. Topics in Psychoanalytic Criticism. 3 units. *Staff*

291. Topics in Popular Culture and the Media. 3 units. *Staff*

300. Value and Evaluation. An advanced seminar dealing with classic problems relating to the concept of value and evaluative behavior (e.g., standards, judgments, canon-formation, taste), as illuminated by contemporary work in critical theory, anthropology, economics, sociology, etc. 3 units. *H. Smith*

The University Program in Marine Sciences

Professor Costlow, *Director* (zoology); Professor Ramus, *Assistant Director for Academic Programs* and *Director of Graduate Student Affairs* (botany); Professors Barber (botany and zoology), Gutknecht (physiology), McClay* (zoology), Pilkey† (geology), and Searles* (botany); Associate Professors C. Bonaventura (physiology), J. Bonaventura (physiology), Forward (zoology), Johnson (geology), Sullivan (biochemistry), and Sutherland (zoology); Professor Emeritus Bookhout (zoology)

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*In residence during summer only.
†In residence during spring or fall only.

Graduate students from any and all academic disciplines are encouraged to take professional training at the Marine Laboratory. The program operates year-round, providing course work in the marine sciences, an active seminar program, and facilities supporting dissertation research. Resident graduate students represent the Departments of Biochemistry, Botany, Forestry and Environmental Studies, Geology, Physiology, and Zoology. Ordinarily, dissertation advisers are resident as well, although this need not be the case. The Marine Laboratory has available several graduate student instructional assistantships during the academic year, including summer. In addition, tuition credits obtained from fellowship support may be applied to courses given both at the Marine Laboratory and the Durham campus.

Persons interested in graduate work in marine sciences should apply through one of the appropriate departments. Forms may be obtained from the Graduate School.

Applications for summer courses at the laboratory should be addressed to the Admissions Office, Duke University Marine Laboratory, Beaufort, North Carolina 28516. Additional information and the application form are included in the *Bulletin of Duke University: Marine Laboratory.* The application for enrollment in summer courses at the laboratory should be accompanied by transcripts of undergraduate and graduate work. Applications should be received as early as possible. Graduate students planning to enroll in courses or seminars offered during the fall or spring at the Marine Laboratory should notify the Admissions Office of the Marine Laboratory of such intent *prior* to the beginning of the respective semester.

Students registering for research should do so under the appropriate departmental numbers.

The following courses are offered at Beaufort. See the *Bulletin of Duke University: Marine Laboratory* for the current schedule of courses.

FALL, SPRING, OR SUMMER PROGRAM AT BEAUFORT

For Juniors, Seniors, and Graduates

203. Physical Oceanography. Physical processes in the oceans: the physical properties of seawater, the dynamics of currents, waves and tides, and the transmission of light and sound in the sea. Prerequisite: Physics 41 or 51. C-L: Geology 203. 2 units. *Johnson*

203L. Marine Ecology. Application of ecological theory to marine systems. Mathematical properties of population growth and species interactions; field and laboratory projects with computer-assisted analysis of data. Practice in scientific writing. Readings from current scientific publications. Prerequisites: introductory biology or invertebrate zoology and calculus; knowledge of statistics helpful. C-L: Zoology 203L. 6 units. *Sutherland*

205S. Geological Oceanography. The geology of ocean basins, including origin, bottom physiography, sediment distribution, and sedimentary processes. Not open to students who have taken Geology 206S. C-L: Geology 205S. 4 units. *Johnson*

209S. Marine Sediments. Sedimentary processes in nearshore, shelf, and deep-sea environments. Emphasis on field methods and laboratory analyses. Requirement of term paper. C-L: Geology 209S. 4 units. *Johnson*

209, 210. Independent Study. A tutorial designed for students who are interested in either a laboratory or a library project in biochemistry. C-L: Biochemistry 209, 210. Credit to be arranged. *Staff*

210. Individual Study. Directed reading and research in physiology. Prerequisite: consent of Director of Graduate Studies. C-L: Physiology 210. Credit to be arranged. *Staff*

215L. Primary Productivity in the Seas. The biological flux of carbon in the coastal and open seas involving phytoplankton, seaweeds, seagrasses, and marshgrasses. The contributions of these primary producers to food chain processes and global atmospheric-sedimentary cycles, as well as the ecological consequences of variations in photosynthetic mechanisms. Prerequisites: introductory biology and chemistry. C-L: Botany 215L and Zoology 215L. 4 units. *Barber and Ramus*

218. Barrier Island Ecology. Adaptation of plants to barrier island migration and other physical characteristics of the coastal environment. Major emphasis on management of barrier beaches from Maine to Texas and the impact of human interference with natural processes. Field studies. Prerequisite: course in general ecology. C-L: Botany 218 and Forestry and Environmental Studies 218. 6 units. *Staff*

219L. Benthic Marine Algae. Morphology, reproduction, life histories, systematics, and natural history of seaweeds. Lectures, laboratories, and field work in ocean and estuaries. Prerequisite: introductory biology; plant diversity recommended. C-L: Botany 219L. 4 units. *Searles*

245L. Macromolecules, Ecology, and Evolution. The structure and function of protein and nucleic acid molecules with particular emphasis on the application of molecular techniques to questions in ecological, systematic, and evolutionary theory. C-L: Biochemistry 245L. 3 units. *Sullivan*

250L. Physiology of Marine Animals. Environmental factors, biological rhythms, and behavioral adaptations in the comparative physiology of marine animals. Prerequisites: introductory biology and chemistry. C-L: Zoology 250L. 4 units. *Forward*

274L. Marine Invertebrate Zoology. Structures, functions, and habits of invertebrate animals under natural and experimental conditions. Field trips included. Not open to undergraduate students who have had Zoology 176L except by consent of Director of Undergraduate Studies. Prerequisite: introductory biology. C-L: Zoology 274L. 6 units. *Staff*

278L. Invertebrate Developmental Biology. Gametogenesis, fertilization, and development of invertebrates, with emphasis on experimental studies of prelarval stages. Prerequisite: consent of instructor. C-L: Zoology 278L. 6 units. *McClay and visiting staff*

295S. Advanced Topics in Geology: Continental Margin Sedimentation. Sediment composition and distribution on the continental margin, with emphasis on North Carolina barrier island/lagoon, shelf and slope environments. The course includes field work and laboratory analyses of sediments as well as readings and discussion of the current literature. Prerequisite: Geology 205S or Geology 206S or consent of instructor. 6 units. *Johnson and visiting staff*

353, 354. Research. To be carried on under the direction of the appropriate staff members. (For graduate students only.) Hours and credit to be arranged. C-L: Zoology 353, 354. *Staff*

359, 360. Research. Individual investigation in the various fields of botany. (For graduate students only.) C-L: Botany 359, 360. Credit to be arranged. *Staff*

371, 372. Advanced Topics in Geology. To meet the individual needs of graduate students for independent study in various environmental sedimentary fields. 1 to 3 units. *Staff*

Seminar. Special topics in the marine sciences. Exploration at the advanced level of current research in the marine sciences. Subject dependent on faculty and student interests. C-L: Biochemistry 220S, 265S, 266S; Botany 295S, 296S; Physiology 219S; and Zoology 295S, 296S. 2 units. *Staff*

COURSES CURRENTLY UNSCHEDULED

204. Chemical Oceanography. (C-L: Geology 204.)

219S. Membrane Physiology. (C-L: Physiology 219S.)

220L, 220S. Adaptations of Organisms to the Marine Environment. (C-L: Biochemistry 220L, 220S.)

247L. Plant Ecology. (C-L: Botany 247L.)

263L. Tropical Seaweeds. (C-L: Botany 263L.)

266S. Marine Biochemistry and Genetics. (C-L: Biochemistry 266S.)

276. Comparative and Evolutionary Biochemistry. (C-L: Biochemistry 276.)

Mathematics

Professor Reed, *Chairman* (215 Physics); Associate Professor Moore, *Director of Graduate Studies* (135D Physics); Professors Allard, Beale, Griffiths, Schaeffer, Shoenfield, Warner, and Weisfeld; Associate Professors Burdick, Hodel, Kitchen, Kraines, Lawler, Morrison, Pardon, Scoville, Smith, and Venakides; Assistant Professors Cheney, Gardner, Nance, Saper, Schoen, Stern, and Sylvester; Adjunct Professor Chandra; Visiting Assistant Professor Edelstein-Keshet

Graduate work in the Department of Mathematics is offered leading to the A.M. and Ph.D. degrees. Admission to these programs is based on the applicant's undergraduate academic record, level of preparation for graduate study, the Graduate Record Examination, and letters of recommendation.

All A.M. and Ph.D. candidates are required to pass a qualifying examination after completing their first year of graduate study. The A.M. degree with a major in mathematics is awarded upon completion of 30 units of graded course work and passing the qualifying examination. A thesis may be substituted for 6 units of course work only under special circumstances.

Candidacy for the Ph.D. is established by passing the qualifying examination at the Ph.D. level, completing the department's foreign language requirement, and passing an oral preliminary examination. The preliminary examination is normally taken at the beginning of the third year. The preliminary examination is conducted by a committee selected by the rules of the Graduate School and the department. The examination can, at the student's option, consist of questions based either on the student's course work at Duke or on the specific area of research plus a minor subject selected by the student.

After admission to candidacy, the Ph.D. degree is awarded on the basis of the student's scholarly ability as demonstrated by the dissertation and its defense. The dissertation is the most important requirement in the award of the Ph.D. degree.

For Seniors and Graduates

200. Introduction to Algebraic Structures I. Laws of composition, groups, rings; isomorphism theorems; axiomatic treatment of natural numbers; polynomial rings; division and Euclidean algorithms. Prerequisite: Mathematics 104 or equivalent. 3 units. *Staff*

201. Introduction to Algebraic Structures II. Vector spaces, matrices and linear transformations, fields, extensions of fields, construction of real numbers. Prerequisite: Mathematics 200 or equivalent. 3 units. *Staff*

203. Basic Analysis I. Topology of R^n, continuous functions, uniform convergence, compactness, infinite series, theory of differentiation, and integration. Not open to students who have had Mathematics 139. Prerequisite: Mathematics 104. 3 units. *Staff*

204. Basic Analysis II. Inverse and implicit function theorems, differential forms, integrals on surfaces, Stokes' theorem. Not open to students who have had Mathematics 140. Prerequisite: Mathematics 203. 3 units. *Staff*

205. Topology. Elementary topology, surfaces, covering spaces, Euler characteristic, fundamental group, homology theory, exact sequences. Prerequisite: Mathematics 104. 3 units. *Staff*

206. Differential Geometry. Geometry of curves and surfaces, the Serret-Frenet frame of a space curve, the Gauss curvature, Codazzi-Mainardi equations, the Gauss-Bonnet formula. Prerequisite: Mathematics 104. 3 units. *Staff*

221. Numerical Analysis I. C-L: Computer Science 221. 3 units. *Gallie, Patrick, or Utku*

222. Numerical Analysis II. See C-L: Computer Science 222. 3 units. *Douglas, Gallie, Patrick, Rose, or Utku*

230. Mathematical Methods in Physics and Engineering I. Heat and wave equations, initial and boundary value problems, Fourier series, Fourier transforms, potential theory. Not open to students who have had Mathematics 114. Prerequisites: Mathematics 103 and 104 or equivalents. 3 units. *Staff*

231. Mathematical Methods in Physics and Engineering II. Green's functions, propagators, integral equations, spectral theory on Hilbert space, Fredholm alternative, variational methods. Prerequisite: Mathematics 114 or Mathematics 230. 3 units. *Staff*

234. Mathematics for Quantum Mechanics. Hilbert space, self-adjoint operators, the mathematical model of quantum mechanics, commutation relations, spectral analysis of Hamiltonians, time dependent scattering theory. Prerequisites: Mathematics 230 and 231 or equivalents. 3 units. *Staff*

235. Topics in Mathematical Physics. Group representations, perturbation theory, quantum field theory, statistical mechanics, or general relativity. Prerequisite: Mathematics 231 or equivalent. 3 units. *Staff*

238, 239. Topics in Applied Mathematics. Conceptual basis of applied mathematics, combinatorics, graph theory, game theory, mathematical programming, or numerical solution of ordinary and partial differential equations. Prerequisites: Mathematics 103 and 104 or equivalents. 6 units. *Staff*

240. Applied Stochastic Processes. Applications of probability theory and stochastic processes to economics and environmental science. Markoff chains, optional stopping, queuing theory, decision theory, birth and death processes, and the Monte Carlo method. Prerequisite: Mathematics 135 or equivalent. 3 units. *Staff*

241. Linear Models. Geometric interpretation, multiple regression, analysis of variance, experimental design, analysis of covariance. Prerequisite: Mathematics 136 or equivalent. 3 units. *Staff*

242. Multivariate Statistics. Multinormal distributions, multivariate general linear model, Hotelling's T^2 statistic, Roy union-intersection principle, principal

components, canonical analysis, factor analysis. Prerequisite: Mathematics 241 or equivalent. 3 units. *Staff*

250. Introductory Mathematical Logic. First-order logic, completeness theorem, compactness theorem, introduction to recursive functions, incompleteness theorem. Prerequisite: Mathematics 187 or Mathematics 200 or equivalent. 3 units. *Staff*

251. Set Theory I. Zermelo-Fraenkel axioms, ordinals and cardinals, models of set theory, constructible sets. Prerequisite: Mathematics 187 or Mathematics 200 or equivalent. 3 units. *Staff*

252. Set Theory II. Forcing, large cardinals, determinateness, and other advanced topics. Prerequisite: Mathematics 251. 3 units. *Staff*

258, 259. Topics in Logic. Model theory, recursion theory, set theory, or other fields of logic. Prerequisite: Mathematics 250 or equivalent. 6 units. *Staff*

260. Groups, Rings, and Fields. Groups including nilpotent and solvable groups, p-groups and Sylow theorems; rings and modules including classification of modules over a PID and applications to linear algebra; fields including extensions and Galois theory. Prerequisite: Mathematics 201 or equivalent. 3 units. *Staff*

261. Commutative Algebra. Extension and contraction of ideals, modules of fractions, primary decomposition, integral dependence, chain conditions, affine algebraic varieties, Dedekind domains, completions. Prerequisite: Mathematics 260 or equivalent. 3 units. *Staff*

268, 269. Topics in Algebra. Algebraic number theory, algebraic K-theory, homological algebra, or topological algebra. Prerequisite: Mathematics 260. 6 units. *Staff*

271. Algebraic Topology. Fundamental group and covering spaces, homology groups of cell complexes, classification of compact surfaces, the cohomology ring, and Poincaré duality for manifolds. Prerequisites: Mathematics 171S and 200 or equivalents. 3 units. *Staff*

275. Differential Geometry. Differentiable manifolds, fiber bundles, connections, curvature, characteristic classes, Riemannian geometry including submanifolds and variations of the length integral, complex manifolds, homogeneous spaces. Prerequisites: Mathematics 204 and 260 or equivalents. 3 units. *Staff*

276. Topics in Differential Geometry. Lie groups and related topics, Hodge theory, index theory, minimal surfaces, Yang-Mills fields, exterior differential systems, several complex variables. Prerequisite: Mathematics 275 or consent of instructor. 3 units. *Staff*

277. Topics in Algebraic Geometry. Local theory: affine varieties, algebraic and topological theory of singularities. Global theory over the complex numbers: Riemann surfaces, Jacobians, Kähler manifolds, Hodge theory, theorems of Lefschetz and Kodaira. Scheme theory: schemes, duality theorems, arithmetic varieties. Prerequisite: consent of instructor. 3 units. *Staff*

278, 279. Topics in Topology. Point set, algebraic, geometric, or differential topology. Prerequisite: consent of instructor. 6 units. *Staff*

280. Differential Analysis. Differential calculus, ordinary differential equations, flows, Lie bracket, total differential equations, first order partial differential equations, deRham theory. Prerequisite: Mathematics 140 or equivalent. 3 units. *Staff*

281. Real Analysis I. Measures, Lebesgue integral, L^p-spaces, Daniell integral, differentiation theory, product measures. Prerequisite: Mathematics 140 or equivalent. 3 units. *Staff*

282. Real Analysis II. Metric spaces, fixed point theorems, Baire category theorem, Banach spaces, fundamental theorems of functional analysis, Fourier transform. Prerequisite: Mathematics 281 or equivalent. 3 units. *Staff*

283. Linear Operators. Bounded and unbounded operators on Banach and Hilbert spaces, symmetric and self-adjoint operators, Banach algebras, spectral theorem, unitary groups, compact operators, Fredholm theory, accretive operators, semigroups of operators. Prerequisite: Mathematics 282 or equivalent. 3 units. *Staff*

284. Topics in Functional Analysis. Advanced spectral analysis, operator algebras, nonlinear functional analysis, or structure theory of Banach spaces. Prerequisite: Mathematics 282 or equivalent. 3 units. *Staff*

285. Complex Analysis. Complex calculus, conformal mapping, Riemann mapping theorem, Riemann surfaces. Prerequisite: Mathematics 140 or equivalent. 3 units. *Staff*

286. Topics in Complex Analysis. Geometric function theory, function algebras, several complex variables, uniformization, or analytic number theory. Prerequisite: Mathematics 285 or equivalent. 3 units. *Staff*

288, 289. Topics in Analysis. Harmonic analysis, dynamical systems, geometric measure theory, or calculus of variations. Prerequisites: Mathematics 281 and 285 or equivalents. 6 units. *Staff*

290. Probability. Random variables, independence, expectations, laws of large numbers, central limit theorem, Markoff chains. Prerequisite: Mathematics 281 or equivalent. 3 units. *Staff*

293, 294. Topics in Probability Theory. Ergodic theory, multiparameter stochastic processes and random fields, stochastic control theory, or stochastic differential equations. Prerequisite: Mathematics 290 or consent of instructor. 6 units. *Staff*

295. Fourier Analysis and Distribution Theory. Tempered distributions, Fourier transforms, classical inequalities, and oscillatory integrals. Prerequisites: Mathematics 140 and 285 or equivalents. 3 units. *Staff*

296. Ordinary Differential Equations. Existence and uniqueness theorems for nonlinear systems, well-posedness, two-point boundary value problems, phase plane diagrams, stability, dynamical systems, and strange attractors. Prerequisites: Mathematics 104, 111 or 131, and 203 or 139. 3 units. *Staff*

297. Partial Differential Equations I. Fundamental solutions of linear partial differential equations, hyperbolic equations, characteristics, Cauchy-Kowalevski theorem, propagation of singularities. Prerequisite: Mathematics 140 or equivalent. 3 units. *Staff*

298. Partial Differential Equations II. Elliptic boundary value problems, regularity theorems, the diffusion equation, and nonlinear equations. Prerequisite: Mathematics 297 or equivalent. 3 units. *Staff*

299. Topics in Partial Differential Equations. Hyperbolic conservation laws, pseudo-differential operators, variational inequalities, theoretical continuum mechanics. Prerequisite: 298 or equivalent. 3 units. *Staff*

378-379. Current Research in Topology. 6 units. *Staff*

388, 389. Current Research in Analysis. 6 units. *Staff*

358-359. Current Research in Logic

368-369. Current Research in Algebra

387. Current Research in Mathematical Physics

Program in Medieval and Renaissance Studies

Professor L. Patterson, *Chairman* and *Director of Graduate Studies* (325 Allen)

The graduate Program in Medieval and Renaissance Studies is an interdisciplinary program administered by the Duke University Center for Medieval and Renaissance Studies. In consultation with the Director of Graduate Studies, students in the program select courses in art, history, music, philosophy, religion, language, and literature (classical studies, English, German, and Romance languages). For descriptions of the individual courses see the listings under the specified department.

DEPARTMENT OF ART AND ART HISTORY

230S. Medieval and Byzantine Art and Architecture. *Bruzelius or Epstein*

232S. Romanesque and Gothic Art and Architecture. *Bruzelius*

240. Italian Art. *Goffen or Spencer*

242S. Studies in Italian Renaissance Art. *Goffen or Spencer*

243S. Studies in Northern Art. *Melion*

DEPARTMENT OF CLASSICAL STUDIES

221. Medieval Latin. *Newton*

312. Proseminar in Latin Paleography. *Newton*

DEPARTMENT OF ENGLISH

208. History of the English Language. *Butters or Nygard*

212. Middle English Literature: 1100 to 1500. *Nygard or L. Patterson*

221. Renaissance Prose and Poetry: 1500 to 1660. *DeNeef, Fish, A. Patterson, Randall, or G. Williams*

225. Renaissance Drama: 1500 to 1642. *Randall*

312. Studies in Middle English Literature. *Nygard or L. Patterson*

315. Studies in Chaucer. *Nygard or L. Patterson*

321. Studies in Renaissance Literature. *DeNeef, Fish, A. Patterson, Randall, or G. Williams*

324. Studies in Shakespeare. *A. Patterson, Porter, or G. Williams*

329. Studies in Milton. *DeNeef, Fish, or A. Patterson*

383. Textual Criticism. *G. Williams*

DEPARTMENT OF GERMANIC LANGUAGES AND LITERATURE

205, 206. Middle High German. *Borchardt*

215S. Seventeenth-Century Literature. *Borchardt*

216. History of the German Language. *Staff*

217S. Renaissance and Reformation Literature. *Borchardt*

DEPARTMENT OF HISTORY

221. Problems in the Economic and Social History of Europe, 1200–1700. *Witt*

222. History of the Renaissance. *Witt*

237S. Europe in the Early Middle Ages. *Young*

238S. Europe in the High Middle Ages. *Young*

267S–268S. From Medieval to Early Modern England. *Staff*

DEPARTMENT OF MUSIC

201. Introduction to Musicology. *Bartlet*

211. Medieval Notation. *Staff*

212. Renaissance Notation. *Staff*

221. Music in the Middle Ages: Monophony. *Seebass*

222. Music in the Middle Ages: Polyphony. *Seebass*

223. Music in the Renaissance. *Staff*

312S. Seminar in Renaissance Music. *Staff*

351S. Studies in Musical Iconography. *Seebass*

DEPARTMENT OF PHILOSOPHY

218S. Medieval Philosophy. *Mahoney*
219S. Late Medieval and Renaissance Philosophy. *Mahoney*

DEPARTMENT OF RELIGION

219. Augustine. *Gregg*
236. Luther and the Reformation in Germany. *Steinmetz*
241. Problems in Reformation Theology. *Steinmetz*
334. Theology and Reform in the Later Middle Ages. *Steinmetz*
337. Theology of St. Thomas Aquinas. *Staff*
338. Calvin and the Reformed Tradition. *Steinmetz*
339. The Radical Reformation. *Steinmetz*

DEPARTMENT OF ROMANCE LANGUAGES

French

211. History of the French Language. *Hull*
248. French Literature of the Seventeenth Century. *Staff*
325. French Prose of the Sixteenth Century. *Tetel*
326. Topics in Renaissance Poetry. *Tetel*
391, 392. French Seminar (medieval and Renaissance topics). *Tetel and staff*

Italian

284, 285. Dante. *Caserta*

Spanish

210. History of the Spanish Language. *Garci-Gómez*
251. The Origins of Spanish Prose Fiction. *Wardropper*
253. Cervantes. *Wardropper*
254. Drama of the Golden Age. *Wardropper*
258S. Spanish Lyric Poetry before 1700. *Wardropper*
391, 392. Hispanic Seminar (medieval and Renaissance topics). *Fein, Garci-Gómez, Osuna, Pérez, and Wardropper*

COURSES CURRENTLY UNSCHEDULED

Classical Studies 327. Seminar in Byzantine History
English 210. Old English Literary Tradition
English 310. Studies in Old English Literature
English 380. Studies in Ballad and Folksong
Music 311S. Seminar in Medieval Music
Religion 206. Christian Mysticism in the Middle Ages
Religion 251. The Counter-Reformation and the Development of Catholic Dogma
Religion 344. Zwingli and the Origins of Reformed Theology

Microbiology and Immunology

Professor Joklik, *Chairman* (414A Jones); Professor Willett, *Director of Graduate Studies* (420 Jones); Professors Amos, Bastia, Bolognesi, R. Buckley, Cresswell, Day, Metzgar, Osterhout, Rosse, Seigler, Snyderman, Ward, and Wheat; Associate Professors Adams, Corley, Dawson, Endow, Keene, Linney, Mitchell, and Sage; Assistant Professors Argon, C. E. Buckley III, Finn, Haynes, Kreuzer, McClay, Ostrowski, Pickup, and Pisetsky; Associate Medical Research Professor Miller; Assistant Medical Research Professors Balber, Burdett, and Sedwick

The department offers graduate work leading to the Ph.D. degree. Research programs are available in many areas of molecular prokaryotic and eukaryotic genetics and cell biology—molecular biology, viral oncology, cellular differentiation and development, tumor cell biology, immunogenetics, molecular and cellular immunology, and mycology. The department is also a participating member of the interdisciplinary University Programs in Genetics, Cell and Molecular Biology, Neurobiology, Toxicology, and the Medical Sciences Training Program.

Undergraduate preparation in the biological and physical sciences and in biochemistry is required. A brochure describing the Ph.D. degree program, pre-

requisites for admission, and research in the department may be obtained by writing the Director of Graduate Studies, Box 3020, Duke University Medical Center, Durham, North Carolina 27710.

214. Fundamentals of Electron Microscopy. An introduction to the basics of electron microscopy, specimen preparation, and ultramicrotomy. Open only to graduate students in microbiology and immunology. 2 units. *Miller*

219. Molecular and Cellular Bases of Differentiation. C-L: Anatomy 219, Biochemistry 219, Pathology 219, and Physiology 230. *Counce, McCarty, and staff*

221. Medical Microbiology. An intensive study of common bacteria, viruses, fungi, and parasites which cause disease in humans. The didactic portion of the course focuses on the nature and biological properties of microorganisms causing disease, the manner of their multiplication, and their interaction with the entire host as well as specific organs and cells. 4 units. *Joklik and staff*

234. Introduction to Biostatistical Methods. Elementary statistical procedures having special application to biological research. Special emphasis on the interpretation of parameters and the appropriateness of assumptions in the biological/laboratory setting. Prerequisite: elementary mathematics including college algebra. 3 units. *Dawson*

244. Principles of Immunology. An introduction to the molecular and cellular basis of the immune response. Topics include anatomy of the lymphoid system, lymphocyte biology, antigen-antibody interactions, humoral and cellular effector mechanisms, and control of immune responses. Prerequisites: Zoology 160 and Chemistry 152 and consent of instructor. C-L: Zoology 244. 3 units. *Amos, McClay, and staff*

246S. Parasitic Diseases. Topics in the physiology and immunology of major human and animal parasites with an emphasis on protozoa and schistosomes. Extensive reading in and discussion of current literature. Basic parasitology developed in introductory readings and lectures. Prerequisites: Microbiology and Immunology 244 or 291, and Biochemistry 227 or equivalent. 3 units. *Balber*

252. General Virology and Viral Oncology. The first half of the course will be devoted to a discussion of the structure and replication of mammalian and bacterial viruses. The second half deals specifically with tumor viruses, which are discussed in terms of the virus-cell interaction, the relationship of virus infection to neoplasia, and the role of the immunological response to tumor virus infection. Prerequisite: consent of instructor. 4 units. *Keene and staff*

259. Molecular Biology I: Protein and Membrane Structure/Function. C-L: Anatomy 259, Biochemistry 259, and the University Program in Cell and Molecular Biology. 3 units. *Richardson and staff*

268. Molecular Biology II: Nucleic Acids. C-L: Biochemistry 268, Botany 268, and the University Program in Cell and Molecular Biology. 4 units. *Modrich and staff*

269. Advanced Cell Biology. C-L: Anatomy 269, Botany 269, the University Program in Cell and Molecular Biology, and Zoology 269. 3 units. *Endow and staff*

291. Comprehensive Immunology. An intensive course in the biology of the immune system and the structure and function of its component parts. Major topics discussed are: properties of antigens; specificity of antibody molecules and their biologic functions; cells and organs of the lymphoid system; structure and function of complement; inflammation and nonspecific effector mechanisms; cellular interactions and soluble mediators in lymphocyte activation, replication, and differentiation; regulation of immune responses; neoplasia and the immune system;

molecular structure and genetic organization of *(a)* immunoglobulins, *(b)* histocompatibility antigens, and *(c)* T-cell receptor. 4 units. *Argon, Finn, and staff*

For Graduates

304. Molecular Membrane Biology. An advanced seminar course covering selected aspects of current research on biogenesis and dynamics of various cellular membranes. Emphasis will be on the cell biology of the immune system. Discussion topics will represent the following areas: biosynthesis of membrane proteins; intracellular transport vesicles; endocytosis; signal transduction across the plasma membrane; intracellular organelles and protein sorting; cell interactions in differentiation. Prerequisite: Microbiology 269 or consent of instructor. 2 units. *Argon and Cresswell*

310. Molecular Development. Selected topics of current research using molecular and genetic approaches to study development and developmental gene regulation in eukaryotes. Lectures and student presentations of research with various developmental systems (e.g., C. elegans, Drosophila, mouse teratocarcinoma cells, and mouse embryos) will be included in the course. 2 units. *Bastia, Endow, Linney, and Ostrowski*

323. Topics in Cell and Molecular Biology. An advanced treatment of special topics and recent developments in cell and molecular biology. 2 units. *Staff*

324. Topics in Molecular Genetics. An advanced treatment of selected topics and recent developments in molecular genetics. 2 units. *Staff*

325. Medical Mycology. Comprehensive lecture and laboratory coverage of all the fungi pathogenic for humans. Practical aspects as well as future trends in the mycology, immunology, diagnosis, pathogenesis, and epidemiology of each mycotic agent will be explored. There will be several invited lecturers, each an internationally recognized scientist, discussing his or her particular area of mycological expertise and current research. Prerequisite: consent of instructor. 4 units. *Mitchell*

330. Medical Immunology. A comprehensive course in medical immunology which attempts to define the role that immunology plays in the etiology, diagnosis, nosology, and therapy of human disease. 6 units. *Metzgar and staff*

331.1-331.8. Microbiology Seminar. Current topics in microbiology with seminars presented by students, faculty, and outside speakers. Required course for all students specializing in microbiology. 1 unit each. *Staff*

332.1-332.8. Immunology Seminar. Current topics in immunology with seminars presented by students, faculty, and outside speakers. Required course for all students specializing in immunology. 1 unit each. *Staff*

336. Contemporary Topics in Immunogenetics. Selected themes in immunogenetics with special emphasis on molecular approaches. The major areas discussed are: the nature, interaction, and expression of immunoglobulin genes and T-cell receptor genes, the genes of the major histocompatibility complex, and the genes of the T/t complex. The central ideas discussed include the manner in which cells recognize and interact with each other in phylogeny, ontogeny, and in differentiation; how gene families evolve and interact; and how information about these complex genetic systems is used in basic research and in clinical medicine. Prerequisite: Microbiology and Immunology 244 or 291 or 330 or equivalent. C-L: The University Program in Genetics. 2 units. *Amos and Ward*

COURSES CURRENTLY UNSCHEDULED

219S. Seminar

236. **Statistical Methods in Human Genetics**

242. **Mechanisms of Microbial Pathogenicity**

282. **Molecular Microbiology**

Music

Professor Williams, *Chairman* (105 Mary Duke Biddle Music Building); Professor Silbiger, *Director of Graduate Studies* (067 Mary Duke Biddle Music Building); Associate Professors Seebass and Todd; Assistant Professors Bartlet, Gilliam, Higgins, and Jaffe; Instructor Hill

The Department of Music offers graduate programs leading to the A.M. and Ph.D. degrees in musicology, the A.M. degree in composition, and the A.M. degree in performance practice. The department has traditionally emphasized the study of music within the framework of cultural and intellectual history. To this has been added more recently emphases on theory and analysis, and on performance practice. In addition, there is a strong interest, both within the composition and musicology programs, in opera and musical theater. Students are encouraged to include work outside their main area of concentration in their degree programs.

Nondegree students and especially graduate students from other departments may be admitted to graduate courses by consent of the instructor, according to their level of achievement in the proposed area of study. Students may be admitted to the Program in Medieval and Renaissance Studies (see section on Medieval and Renaissance Studies). A reading knowledge of one foreign language is required for the A.M. in composition, musicology, and performance practice; two languages are required for the Ph.D., (one of which will normally need to be German). For many dissertation topics a third language may be required. During their first term in residence, students in all degree programs will take an advisory test in basic harmony, counterpoint, and score reading, as a result of which certain remedial work may be suggested by the Director of Graduate Studies.

A detailed description of the requirements for the A.M. and Ph.D. is available upon request from the Director of Graduate Studies.

201. Introduction to Musicology. Methods of research on music and its history, including studies of musical and literary sources, iconography, performance practice, ethnomusicology, and historical analysis, with special attention to the interrelationships of these approaches. 3 units. *Seebass or Silbiger*

211, 212. Notation. A comprehensive course tracing the development and changing function of musical notation from *ca*. 900 to *ca*. 1900, including plainchant notations, black notations, white notations, the invention of printing (particularly movable type and engraving), keyboard and lute tablatures, scores. 6 units. *Williams*

213. Theories and Notation of Contemporary Music. The diverse languages of contemporary music and their roots in the early twentieth century, with emphasis on the problems and continuity of musical language. Recent composers and their stylistic progenitors (e.g., Ligeti, Bartók, and Berg; Carter, Schoenberg, Ives and Copland; Crumb, Messiaen, and Webern; Cage, Varèse, Cowell and Stockhausen). 3 units. *Jaffe*

215. Music Analysis. Introduction to the historical, philosophical, and ideological issues raised by music analysis. Intensive study of harmony and voice leading in the works of major tonal composers, with emphasis on the analytic approach of Heinrich Schenker. 3 units. *Todd*

216. Analysis of Twentieth-Century Music. Major currents in twentieth-century analytical thought: Allen Forte's Theory of Sets and Milton Babbitt's Twelve-Tone Theory. Some exploration of issues raised by neotonal composers Bartók and Stravinsky. 3 units each. *Staff*

Courses dealing with selected topics in the period concerned, at a level between simple surveys and advanced seminars:

222. Music in the Middle Ages. 3 units. *Staff*

223. Music in the Renaissance. 3 units. *Staff*

224. Music in the Baroque Era. 3 units. *Staff*

225. Music in the Classic Era. 3 units. *Staff*

226. Music in the Nineteenth Century. 3 units. *Staff*

227. Music in the Twentieth Century. 3 units. *Staff*

290. Independent Study. With the consent of a graduate faculty member and the approval of the Director of Graduate Studies, the student will undertake a specialized research project of his/her own choosing. 3 units. *Staff*

231, 232, 233. Independent Study in Performance Practice and Interpretation. The exploration of significant interpretive and performance-practice issues as they affect a specific repertory. Weekly meetings with a member of the graduate faculty. Prerequisite: consent of instructor and Director of Graduate Studies. 3 units. *Staff*

296S. Analysis of Contemporary Music. Structures, expressive intentions, and functions since 1914. Contemporary orchestral music, American music, European music, popular media, musical tradition, and the contemporary composers. Analysis of works performed in the department's Encounters Series with occasional guest composers present. 3 units. *Jaffe*

297, 298, 299. Composition. The culmination of graduate work in composition leading to the A.M. degree is the candidate's portfolio of original work, to include one major work of at least fifteen minutes in duration and a shorter work. One of these works should be for orchestra and the other for chamber ensemble. A one-act opera may qualify as the larger work. The portfolio should also include shorter works for diverse media to demonstrate the candidate's overall craftsmanship. Students will have weekly independent study sessions with a member of the graduate composition faculty who will supervise the preparation of his or her portfolio. 3 units. *Jaffe*

317S. Seminar in the History of Music. Selected topics. 3 units. *Staff*

318S. Seminar in Performance Practice. A practical seminar in which participants will be expected to perform, to introduce the work to be played or sung, and to outline its interpretative problems. A list of the music concerned will be posted in advance, and all students will participate in the study (if not necessarily in the performance) of the works announced. It is expected that the seminar will cover most periods, from Gregorian chant to twentieth-century repertories. Prerequisite: consent of the instructor. 3 units. *Williams*

341S. History of Music Theory to Rameau. A study of writings on pitch systems (including monochord divisions and hexachord solmization), tonal relationships (including counterpoint and modal theories), and the organization of time (including mensural systems and proportions); implications for performance practice (e.g., intonation and temperaments, rhythm and tempo, *musica ficta*) and for the analysis of music from before 1700. 3 units. *Silbiger*

351S. Studies in Musical Iconography. The history and current trends in musical iconography; iconography as a part of the history of ideas and as

Realienforschung, "the study of real objects." Discussion of papers in the area of interest of participants. 3 units. *Seebass*

361S. Musical Organology. Musical instruments in Western and non-Western music. Classification and organological literature. The primary function of instruments: their construction, their sound, and their impact on performance practice and the musical score. The secondary function of instruments: their social importance, their aesthetic and scientific value, their religious symbolism. Iconography of instruments. 3 units. *Seebass or Williams*

382S. Studies in Ethnomusicology. Ethnomusicology as a branch of musicology. Discussion of papers in African or Southeast Asian music and in the areas of interest of the participants. 3 units. *Seebass*

The University Program in Neurobiology

Professor Diamond, *Director* (psychology); Professors Erickson (psychology), Hall (anatomy), Somjen (physiology), and Vanaman (microbiology and immunology); Associate Professors Graham (pathology) and Kaufman (biochemistry); Assistant Professor Nadler (pharmacology)

Recent advances in neurobiology have resulted in new methods, such as immunohistochemistry, and in closer ties among the various approaches to studying the nervous system. For example, research on the neuroanatomical basis of behavior is more dependent than ever before on the chemical and cellular study of neurons. To keep pace with these changes the program in neurobiology has been designed for a small number of students who wish to study the nervous system at several levels, ranging from the molecular to the behavioral. In planning course work, each student will be guided by an advisory committee whose members come from a variety of departments. All students will be advised to take courses in neuroanatomy, neurophysiology, neuropharmacology, and neuropsychology. The heart of the training is a research apprenticeship that leads to a Ph.D. dissertation. Each student must affiliate with one of the participating departments—anatomy, biochemistry, microbiology and immunology, pathology, pharmacology, physiology, psychology, and zoology—and must meet all the requirements of that department for the Ph.D. degree. Normally, the dissertation adviser and the student will be members of the same department. A complete list of faculty, including research interests, will be made available to prospective students. *See course listings under the participating departments.*

Pathology

Professor Jennings, *Chairman* (301B Davison); Professor D. Bigner, *Director of Graduate Studies* (207 Jones); Professors Adams, Bossen, Bradford, Burger, Fetter, Hackel, Johnston, Klintworth, Koepke, Pizzo, Pratt, Shelburne, Sommer, Vogel, and Wittels; Associate Professors S. Bigner, Elchlepp, Graham, Ideker, McCarty, Michalopoulos, Reimer, Sanfilippo, and Zwadyk; Assistant Professors Abernethy, Crapo, Jirtle, Schold, and Zalutsky; Adjunct Associate Professor Swenberg; Adjunct Assistant Professor Brody; Associate Medical Research Professor Hamilton; Assistant Clinical Professor Vollmer; Assistant Medical Research Professor Wikstrand

The Department of Pathology offers graduate work leading to the M.S. and Ph.D. degrees with areas of specialization such as subcellular and molecular pathology. Course work is designed to give a broad background in classical and modern pathology with emphasis on the application of modern research techniques. Students will be required to take such courses as are necessary to obtain a broad foundation, as well as courses applicable to areas of speciality and

research. Further information including brochures giving details of departmental facilities, staff, trainee stipends, and the M.D.-Ph.D. program are available from the Director of Graduate Studies.

219. Molecular and Cellular Bases of Differentiation. C-L: Anatomy 219, Biochemistry 219, Microbiology and Immunology 219, and Physiology 230. 3 units. *Padilla and staff*

250. General Pathology. The fundamentals of pathology are presented to the student. Lectures developing broad concepts of disease processes are given by the members of the senior staff. The emphasis is placed on etiology and pathogenesis of disease. Lectures. Prerequisites: histology and consent of instructor. 4 units. *Hackel or staff*

251. Laboratory Course in General Pathology. Laboratory session to complement Pathology 250. Gross and microscopic material is correlated with and related to disease processes. Pathology 250 may be taken concurrently. Prerequisites: histology and consent of instructor. 4 units. *Hackel or staff*

258. Cellular and Subcellular Pathology. This course is designed for students wishing to broaden their knowledge of cellular structure and cellular pathology. The course consists of lectures and seminars discussing the alterations in cellular structure and associated functions that accompany cell injury. Prerequisite: consent of instructor. Hours to be arranged. 2 units. *Shelburne and Sommer*

275. Fundamentals of Electron Microscopy and Biological Microanalysis. Emphasis will be placed on preparative procedures including freezing techniques and on the application of electron microscopy to ultrastructural pathology. Scanning electron microscopy, X-ray microanalysis, and scanning ion microscopy will be discussed in addition to conventional transmission electron microscopy. Limited laboratory experience included. 3 units. *Brody, Ingram, Shelburne, and Sommer*

325. Cardiovascular Pathology. Cardiovascular disease processes will be studied, reviewing anatomic, embryologic, and physiologic features, and utilizing case material and gross specimens. Consideration will be given to principles of electrocardiography. Prerequisite: consent of instructor. 3 units. *Hackel*

353. Advanced Neuropathology. This course deals with current problems and research methods related to diseases which affect the nervous system. Prerequisite: consent of instructor. 3 units. *Vogel*

355. Graduate Seminar in Pathology. Discussions outlining the scope of modern pathology. This will include reports of original researchers by members of staff and visitors. 1 unit. *Bigner and staff*

357. Research in Pathology. Independent research projects in various fields of pathology. Hours and credit to be arranged. *Jennings and staff*

361, 362. Autopsy Pathology. A detailed consideration of the morphologic, physiologic, and biochemical manifestations of disease. Emphasis is on individual work in the laboratory with tutorial supervision. Gross dissection; histologic examination; processing; analyzing of morphologic, microbiologic, and biochemical data; and interpretation of results. For advanced students. Prerequisites: Pathology 250 and consent of instructor. 3 to 6 units each. *Adams and staff*

364. Systemic Pathology. Systematic presentation of the characteristics of disease processes as they affect specific organ systems. Prerequisite: consent of instructor. 6 units. *Hackel and staff*

367. Special Topics in Pathology. Special problems in pathology will be studied with a member of the senior staff; the subject matter will be individually arranged. Hours to be arranged. 2 to 4 units. *Jennings and staff*

369. Ophthalmic Pathology. This course will consist of lectures, seminars, and laboratory sessions. The normal anatomy and embryology of the eye will be reviewed as a basis for the study of the various ocular disease processes. The more common diseases of the eye will be considered in detail. Problems in ophthalmic pathology will be discussed together with methods of solving them. 3 units. *Klintworth*

370. Developmental Pathology and Teratology. A systematic study of disease processes involving the prenatal, natal, and postnatal period. Emphasis will be placed on developmental anatomy and teratogenesis. The format includes seminars and clinicopathologic correlations derived from gross and microscopic material. Prerequisites: Pathology 250 and anatomy and histology. 3 units. *Bradford*

374. Pulmonary Pathology and Postmortem Pathophysiology. Emphasis will be on pulmonary pathology and pathophysiology of infectious, metabolic, environmental, and neoplastic diseases, and certain diseases of unknown etiology (e.g., sarcoid, alveolar proteinosis). Ventilatory experiments will be done on excised human lungs. 3 units. *Pratt*

377. Pathology of the Kidney. The course includes a comprehensive study of pathological, immunological, and clinical features of glomerulonephritis, and pyelonephritis, as well as of metabolic, congenital, and neoplastic renal disorders. Lectures will be supplemented with gross and microscopic specimens, demonstrations, and special library studies. 3 units. *Sanfilippo*

380. Diagnostic Immunology. Diagnostic and laboratory procedures used in evaluating immunologic diseases: especially autoimmune, infectious, immunodeficiency, immunoproliferative, and hypersensitivity disorders. Emphasis is placed on the theoretical and practical aspects of testing procedures and their proper interpretation. Prerequisite: permission of instructor. 2 units. *R. Buckley, Sanfilippo, Snyderman, and Zwadyk*

381. Cancer Biology. Emphasis of the course will be on cellular biology of the cancer cell. The instructors will present topics on aspects of cancer research and will attempt to correlate them with the biologic and clinical behavior of specific forms of neoplasia. 2 units. *Falletta and Michalopoulos*

382. General Pathology for Toxicologists. General principles of pathology using examples from human and experimental toxicological disease. Prerequisites: courses in biochemistry, physiology, and histology (histology may be taken concurrently). 3 units. *Graham, Jennings, and pathologists from UNC and Research Triangle Park*

COURSES CURRENTLY UNSCHEDULED

360. Cytochemistry

Pharmacology

Professor Kirshner, *Chairman* (439 Nanaline H. Duke); Professor Mills, *Director of Graduate Studies* (432 Nanaline H. Duke); Professors Abou-Donia, Ellinwood, Lack, Menzel, Ottolenghi, Schanberg, Slotkin, Watkins, and Wilder; Associate Professors Davis, Kuhn, McNamera, Nadler, Rosen, Strauss, and Whorton; Assistant Professors Schwartz and Strom; Professor Emeritus Bernheim; Medical Research Professor Elion; Associate Medical Research Professor Wilson; Assistant Medical Research Professors Bartolome, Bell, Lapadula, Seidler, Smith, and Wolpert

The Department of Pharmacology offers a graduate program which leads to the Ph.D. degree. Training is available in the areas of behavioral, biochemical, cardiovascular, developmental and endocrine pharmacology, neuropharmacology,

and toxicology. Because pharmacology is an interdisciplinary field, the department gives serious consideration to applicants with strong undergraduate backgrounds in biological, chemical, and neural or behavioral sciences. There is no foreign language requirement.

For Seniors and Graduates

200. Pharmacology: Mode Action of Drugs. Studies and discussion of the pharmacological action of drugs in terms of biochemical and physiological processes. Four lectures, one clinical correlation, and two conferences per week. 5 units. *Staff*

210, 211. Individual Study and Research. Directed reading and research in pharmacology. Prerequisite: consent of Director of Graduate Studies. 3 to 9 units each. *Staff*

219. Tutorial in Pharmacology. Guided independent study of original literature. Credit to be arranged. *Staff*

256. Human Nutrition. Nutrition principles with emphasis on physiology and pharmacology. Topics include the chemical basis for nutrient requirements, application to practical diets; parenteral nutrition; influence of dietary intake on disease (cardiovascular disease, diabetes, and inborn errors of metabolism); optimal dietary intake; impact of food technology on human nutrition, growth, maturation, and lactation; and recent advances in micronutrient requirements. 2 units. *Menzel*

280. Student Seminar in Pharmacology. Preparation and presentation of seminars to students and faculty on topics of broad interest to pharmacology. Required of all pharmacology graduate students. 2 units. *Whorton*

For Graduates

314. Integrated Case Studies in Toxicology. Students are assigned topics relative to their chosen research discipline in toxicology and are asked to develop case studies to present at a roundtable workshop. Emphasis on review and analysis of toxicological problems from a holistic (multidisciplinary) viewpoint. C-L: Forestry and Environmental Studies 314. Spring. 1 unit. *Abou-Donia*

330. Pharmacological Basis of Clinical Medicine. Detailed analysis of the mechanisms of action and rationale for use of pharmacologic agents in disease states. 4 units. *Bjornsson and staff*

331. Laboratory Methods in Pharmacology. Tutorial laboratory training in various fields of pharmacology including neuropharmacology, cardiovascular pharmacology, biochemical pharmacology, and biophysical pharmacology. Prerequisite: consent of instructor. 3 to 6 units. *Staff*

333. Principles of Pharmacology and Toxicology I. Drug absorption, distribution, excretion and metabolism, pharmacokinetics, Hansch correlation of structure and activity, stereochemistry, and drug action. May be taken separately from Pharmacology 334. 4 units. *Slotkin and staff*

334. Principles of Pharmacology and Toxicology II. Drug and hormone receptors and target cell responses, cellular actions of drugs and toxic substances, mechanisms of toxicity and antidoting, adverse drug reactions and interactions, behavioral techniques in pharmacology. Prerequisite: Pharmacology 333 or permission of instructor. 4 units. *Rosen, Slotkin, and staff*

347, 348. Seminar in Toxicology. C-L: Biochemistry 347, 348. 1 unit per semester. *Abou-Donia and Lynn*

354. Mammalian Toxicology. Principles of toxicology as related to humans. Emphasis on the molecular basis for toxicity of chemical and physical agents. Subjects include metabolism and toxicokinetics, toxicologic evaluation, pesticides, metals and industrial chemicals, solvent toxicity, food additives, natural toxins, radiation and radioactive materials; mutagenicity, pathology, carcinogenicity, immunology, teratogenicity; reproductive system, pulmonary, liver, kidney, eye, blood, behavioral cardio- and neurotoxicology; management of poisoning, epidemiology, risk assessment and regulatory toxicology. Taught in alternate years in the spring semester. 4 units. *Abou-Donia and staff*

360. Neuropharmacology. Seminar-lecture course emphasizing neurotransmitter mechanisms and the mechanisms of action of drugs used to modify nervous system function. Material will be drawn from recent literature. Prerequisite: Physiology 270 or consent of instructor. 3 units. *Nadler*

364. Neurotoxicology. Adverse effects of drugs and toxicants on the central and peripheral nervous system; target sites and pathophysiology aspects of neurotoxicity; factors affecting neurotoxicity, screening and assessment of neurotoxicity in humans; experimental methodology for detection and screening of chemicals for neurotoxicity. 3 units. *Abou-Donia and staff*

370. Neurobiology I. Interdisciplinary approach to neuronal function at the cellular and molecular levels. Focus is on the anatomy, biophysics, biochemistry, and pharmacology of conductance and transmission of the neuronal impulse. C-L: Anatomy 370 and Physiology 370. 3 units. *Kirshner and staff*

372. Research in Pharmacology. Laboratory investigation in various areas of pharmacology. Credit to be arranged. *Staff*

417. Cellular Endocrinology. Current concepts of the mechanisms of action of hormones at the cellular level, including hormone-receptor interactions, secondary messenger, regulation of protein synthesis, growth and differentiation, control of salt and water balance, regulation of substrate storage and mobilization, modulation of hormone secretion. C-L: Physiology 417. 2 units. *N. Anderson, Caron, Padilla, and guest faculties*

423. Neurobiological Basis of Behavior. The course surveys neuroanatomical, neurophysiological, neurochemical, and neuropharmacological evidence of central nervous system function as it relates to normal and abnormal behavior. Clinical description, measurement of function, as well as the biological substrates of affective disorders and psychoses will be emphasized. Scientific bases of current therapeutic procedures, especially psychopharmacological, will be examined. Prerequisite: Familiarity with basic neuroanatomy, neurophysiology, and neuropharmacology is assumed. 4 units. *Ellinwood and staff*

COURSES CURRENTLY UNSCHEDULED

260S. Interactions of Differentiated Cells

301. Physical Chemistry of Aqueous Solutions

Philosophy

Professor Sanford, *Chairman* (201D West Duke); Associate Professor Posy, *Director of Graduate Studies* (201C West Duke); Professors Golding, Mahoney, and Peach; Associate Professor Brandon; Assistant Professors Ferejohn, Jackson, and Roderick; Professor Emeritus Welsh

The Department of Philosophy offers graduate work leading to the A.M. and Ph.D. degrees. Tutorial work complements formal instruction. Students may, after

taking a balanced program, specialize in any of the following fields: the history of philosophy, logic, philosophy of science, epistemology, metaphysics, philosophy of mind, philosophical analysis, ethics, aesthetics, political philosophy, philosophy of law, philosophy of medicine, and philosophy of religion.

Individual programs of study are developed for each student. Prior to being admitted to candidacy for the Ph.D. degree, the student must demonstrate a competence in one foreign language and must successfully complete a series of essays and examinations covering the following: logic and formal philosophy; value theory; metaphysics, epistemology, and philosophy of science; and the history of philosophy. In these exercises students are expected to combine factual knowledge with critical understanding.

Work in a minor or related field, not necessarily confined to any one department, is encouraged but not required. A minor normally includes 6 units for the A.M. or the Ph.D. degree and may include more as a student's program requires or permits.

A student who meets the general requirements of the Graduate School may earn the A.M. degree in philosophy by passing an oral master's examination. This examination, which can be the defense of either a master's thesis or an alternative academic exercise approved by the department and the student's committee, is normally given in the student's fourth term of full-time registration. The examination can be given earlier in two special circumstances:

1. A student with a strong undergraduate background in philosophy who satisfies the department of his or her qualifications by submitting several samples of written work before beginning the program may be admitted to the master's program with the understanding that the master's examination can be given in the second or third term of full-time registration.

2. A student who combines the A.M. program in philosophy with another advanced degree program, such as the programs for the J.D., the M.D., or the Ph.D. in another field, will register as a full-time graduate student of philosophy for only two terms, the minimum registration that meets the general requirements of the Graduate School for the A.M. degree. These two terms of full-time registration need not be consecutive, and their position in the student's overall program is determined in individual cases. A student in a combined program will normally do some work in philosophy while registered in the student's primary program and do some work in the primary field while registered in philosophy. The master's examination can be given in the second term of full-time registration as a philosophy graduate student or in a later term when the student is registered in the primary program.

A student in the philosophy Ph.D. program who meets the general requirements of the Graduate School for the A.M. degree may earn this degree by completing the preliminary exercises for the Ph.D. degree.

A reading knowledge of at least one foreign language, ancient or modern, is required for the Ph.D. degree. Students must satisfy this requirement by the end of the fifth semester of residency. More than one language may be required where this is judged appropriate to the research demanded by the candidate's dissertation.

For Seniors and Graduates

203S. Contemporary Ethical Theories. The nature and justification of basic ethical concepts in the light of the chief ethical theories of twentieth-century British and American philosophers. 3 units. *Golding or Jackson*

204S. Philosophy of Law. Natural law theory and positivism, the idea of obligation (legal, political, social, moral), and the relation of law and morality. 3 units. *Golding*

205S. Topics in Philosophy of History. Nature of historical knowledge and inquiry; theories of the historical process. 3 units. *Staff*

206S. Responsibility. The relationship between responsibility in the law and moral blameworthiness; excuses and defenses; the roles of such concepts as act, intention, motive, ignorance, and causation. 3 units. *Golding*

208S. Political Values. Analysis of the systematic justification of political principles and the political values in the administration of law. 3 units. *Golding or Jackson*

211S. Plato. Selected dialogues. 3 units. *Ferejohn*

217S. Aristotle. Selected topics. 3 units. *Ferejohn*

218S. Medieval Philosophy. Selected problems. C-L: Medieval and Renaissance Studies. 3 units. *Mahoney*

219S. Late Medieval and Renaissance Philosophy. Selected problems. C-L: Medieval and Renaissance Studies. 3 units. *Mahoney*

225S. British Empiricism. A critical study of the writings of Locke, Berkeley, or Hume with special emphasis on problems in the theory of knowledge. 3 units. *Peach*

227S. Continental Rationalism. A critical study of the writings of Descartes, Spinoza, or Leibniz with special emphasis on problems in the theory of knowledge and metaphysics. 3 units. *Peach*

228S. Recent and Contemporary Philosophy. A critical study of some contemporary movements, with special emphasis on analytic philosophers. 3 units. *Posy*

230S. The Meaning of Religious Language. C-L: Religion 230S. 3 units. *Poteat*

231S. Kant's *Critique of Pure Reason*. 3 units. *Posy*

233S. Methodology of the Empirical Sciences. Recent philosophical discussion of the concept of a scientific explanation, the nature of laws, theory and observation, probability and induction, and other topics. Prerequisite: consent of instructor. 3 units. *Brandon*

234S. Problems in the Philosophy of Biology. Selected topics with emphasis on evolutionary biology: the structure of evolutionary theory, adaptation, teleological or teleonomic explanations in biology, reductionism and organicism, the units of selection and sociobiology. Prerequisite: consent of instructor. C-L: Botany 234S. 3 units. *Brandon*

235S. Hegel and Marx. Hegel's philosophy and its influence on Marx. 3 units. *Roderick*

250S. Topics in Formal Philosophy. Topics selected from formal logic, philosophy of mathematics, philosophy of logic, or philosophy of language. 3 units. *Posy*

251S. Epistemology. Selected topics in the theory of knowledge, for example, conditions of knowledge, scepticism and certainty, perception, memory, knowledge of other minds, and knowledge of necessary truths. 3 units. *Sanford*

252S. Metaphysics. Selected topics: substance, qualities and universals, identity, space, time, causation, and determinism. 3 units. *Sanford*

253S. Philosophy of Mind. Analysis of concepts such as thought and belief; issues such as mind-body relations, thought and action, the nature of persons, and personal identity. 3 units. *Sanford*

254S. Philosophy of Religion. Topics such as proofs of the existence of God; meaningfulness of religious language; the problems of evil, immortality, and resurrection. 3 units. *Staff*

291S, 292S. Special Fields of Philosophy. 3 units each. *Staff*

For Graduates

311. Philosophy and Medicine. The scope of medicine as a philosophical problem, the concept of health, and investigation of ethical issues arising in medical contexts. Prerequisite: consent of instructor. 3 units. *Golding*

331, 332. Seminar in Special Fields of Philosophy. 3 units each. *Staff*

COURSES CURRENTLY UNSCHEDULED

202S. Aesthetics: The Philosophy of Art

232S. Recent Continental Philosophy

Physical Therapy

Professor Bartlett, *Chairman* (045 Hospital); Associate Professor Branch, *Director of Graduate Studies* (045 Hospital); Associate Professor Villanueva; Assistant Professors Duncan and Horton; Assistant Clinical Professor Riordan; Clinical Associates Dore and Lawrence

The Department of Physical Therapy offers an entry level professional program leading to the M.S. degree. To be eligible for admission to the program, applicants must have obtained a baccalaureate degree and have a background in the basic sciences and social sciences, including course work in biology, chemistry, physics, and psychology.

The program is designed to provide for integration of classroom knowledge and clinical learning experiences essential for the competent practice of physical therapy. In view of this integrated curriculum, failure in a major course within a semester would prevent the student from continuing in the program. Major courses are all courses offered by the Department of Physical Therapy as well as required courses offered by the Department of Anatomy. A grade of *F* (or *noncredit* in the case of Physical Therapy 342, 343, and 344) in any of these courses will occasion withdrawal from the program. Program requirements also include a comprehensive examination at the completion of the curriculum and a research project. Further information may be obtained from the Director of Graduate Studies, Department of Physical Therapy, Box 3965, Duke University Medical Center, Durham, North Carolina 27710.

210. Independent Study. Designed for nonmajors. Prerequisite: consent of instructor. Credit to be arranged. *Staff*

301. Introduction to Scientific Inquiry. Theory and methods of research process, research design, data collection, preparation of a research proposal. 2 units. *Riordan and staff*

302. Research. Development of a research project protocol. 1 unit. *Staff*

303. Research. Completion of a research project under the supervision of a faculty adviser; instruction in statistical techniques and the use of the computer. 3-5 units. *Staff*

304. Seminar in Applied Neurophysiology. Selected topics in neurophysiology, with emphasis on those most relevant to the theory and practice of physical therapy. 1 unit. *Staff*

313. Physical Agents. Physical aspects and physiological effects of selected physical agents, including massage, superficial heat and cold, ultraviolet, diathermy, and ultrasound. 2 units. *Branch*

314. Electrotherapy and Electrodiagnosis. Physical aspects and therapeutic effects of electrical currents. Electrodiagnostic testing, introduction to electromyography and nerve conduction studies, and principles and application of biofeedback. 1–2 units. *Staff*

317. Kinesiology. Fundamentals of arthrology and myology, movement and joint description, surface anatomy, principles of biomechanics and anthropometry. 2 units. *Villanueva*

318. Arthrology and Pathokinesiology. Detailed study of the arthrology and kinesiology of the trunk and limbs during normal and pathological conditions, with emphasis on the sequential electromyographic and joint motion analysis of body segments during selected human movement patterns, including locomotion. 3 units. *Villanueva*

319. Introduction to Evaluation and Patient Care. Orientation to basic patient care skills, including reaction to illness. Introduction to Problem-Oriented Record System. Principles and methods of evaluation, including assessment of muscle function, joint mobility, neurological and respiratory function, posture, gait, and physical level of independence. Opportunities for direct patient care in laboratory and clinic. 3 units. *Horton and Villanueva*

320. Evaluation and Therapeutic Procedures I. Specific assessment of neuromuscular and cardiopulmonary functions. Physiological basis of therapeutic intervention and specific exercise programs. 3 units. *Duncan*

321. Evaluation and Therapeutic Procedures II. Assessment and treatment of specific neuromuscular and cardiopulmonary problems. Introduction to techniques of neuromuscular facilitation. 2 units. *Duncan and staff*

322. Evaluation and Therapeutic Procedures III. Introduction to the neurophysiological basis for evaluation and treatment of children and adults with central nervous system disorders; emphasis on assessment of abnormal movement and selection of appropriate therapeutic programs. Problems associated with spinal cord injuries, methods of therapeutic intervention, and functional testing. 3 units. *Bartlett and Duncan*

332. Physical Therapy and Health Services: Administration and Issues. Planning, organizing, delivering, and evaluating physical therapy and health services. Examination of health policy and issues. Principles of administration, leadership styles, and management roles. 2 units. *Bartlett and Riordan*

333. Pediatrics. Description and observation of the development of the normal child, followed by the discussion of various pediatric problems. 2 units. *Staff*

334. Introductory Pathology. A review of normal cells and tissues; fundamentals of pathology with emphasis on broad concepts of disease. 2 units. *Branch*

335. Orthopedics. Detailed examination of the musculoskeletal system, through lecture and laboratory, and the application of findings to the establishment of physical therapy care plans. Introduction to common orthopedic problems and their medical and surgical management. 2 units. *Lawrence*

336. Medical Sciences. The clinical manifestations and management of common medical and surgical disorders. Lectures by physicians, physical therapists, clinical pharmacists, and other health personnel; selected laboratory experiences. Areas covered include prosthetics and orthotics, burns, rheumatology, cardiopulmonary disorders, neurology, neurosurgery, hematology, and gerontology. Seminars in patient management. 3 units. *Branch and staff*

340. Special Topics in Physical Therapy. Opportunity for study under the direction of an individual staff member. Prerequisite: consent of Director of Graduate Studies. Credit to be arranged. *Staff*

342. Directed Clinical Experience in Physical Therapy I. Short-term observational and supervised learning experiences in local physical therapy settings. 1 unit. *Clinical staffs*

343. Directed Clinical Experience in Physical Therapy II. Full-time supervised clinical learning experiences in physical therapy settings within limited radius of the University. 2 units. *Clinical staffs*

344. Directed Clinical Experience in Physical Therapy III. Full-time supervised clinical learning experiences in physical therapy settings throughout the country. 3 units. *Clinical staffs*

COURSES CURRENTLY UNSCHEDULED

324. Prosthetics and Orthotics

Physics

Professor De Lucia, *Chairman* (118 Physics); Professor Fairbank, *Director of Graduate Studies* (112 Physics); Professors Biedenharn, Bilpuch, Cusson, Evans, Goshaw, Han, Herbst, Meyer, Roberson, Robinson, Walker, Walter, and Weller; Associate Professors Behringer, Fortney, Palmer, and Thomas; Assistant Professors Howell and Oh; Professor Emeritus Lewis; Adjunct Professors Ciftan, Guenther, O'Foghludha, Robl

The Department of Physics offers graduate work for students wishing to earn the A.M. or Ph.D. degree. In addition to a balanced program of basic graduate courses, the department offers specialized courses and seminars in several fields in which research is being done by faculty and staff.

With the help of faculty advisers, students select a course program to fit their needs, including work in a related field, usually mathematics or chemistry. Students are encouraged to begin research work early in their careers.

For Seniors and Graduates

211. Modern Physics. Fundamental concepts of quantum theory applied mainly to study of atomic structure and spectra, and to statistical physics. Prerequisites: Physics 181 and Mathematics 111. 3 units. *Herbst*

214. Introduction to Solid-State Physics. C-L: Electrical Engineering 214. 3 units. *Hacker or staff*

215. Introduction to Quantum Mechanics. Fundamental postulates; wave mechanics and elementary applications; operators, eigenvalues, and eigenfunctions; angular momentum and rotations; spin and coupling of angular momenta; perturbation theory, transition rates, and selection rules; identical particles; applications. Prerequisites: Physics 181 and 211; Mathematics 111 and 114 (may be taken concurrently). 3 units. *Robinson*

217S, 218S. Advanced Physics Laboratory and Seminar. Experiments involving the fields of electricity, magnetism, heat, optics, and modern physics. 6 units. *Meyer*

220. Electronics. Basic elements of modern electronics including AC circuits, transfer functions, solid-state circuits, transistor circuits, operational amplifier applications, digital circuits, and computer interfaces. 3 units. *Fortney*

240. Computer Applications to Physical Measurement. Hardware and software techniques for computer-assisted data acquisition, display, and control in the modern experimental environment. Theory and application of discrete signal analysis including digital filters, Z-transform, and fast Fourier transform. Lecture

and laboratory. Prerequisite: Physics 171 or 220 or consent of instructor. 3 units. *Fortney*

244. Nuclear and Particle Physics. Current ideas and models in nuclear and particle physics. Experimental methods; nuclear structure; nuclear reactions; families of elementary particles; quarks and gluons; weak interactions. Prerequisite: Physics 211. 3 units. *Oh*

For Graduates

302. Advanced Mechanics. The fundamental principles of Newtonian mechanics, general dynamics of systems of particles and rigid bodies, the methods of Lagrange and Hamilton, generalized mechanics. 3 units. *Han*

303. Statistical Mechanics. Fundamental laws of thermodynamics and statistical mechanics with applications to physics and chemistry. Classical and quantum ideal gases; approximate methods for real gases and liquids. Prerequisite: Physics 215. 3 units. *Behringer*

304. Advanced Topics in Statistical Mechanics.* This course will vary from year to year. Possible topics include Fermi liquids, systems of bosons, many-body theory, nonequilibrium statistical mechanics. Prerequisites: Physics 303 and 316. 3 units. *Staff*

305. Introduction to Nuclear Physics. Phenomenological aspects of nuclear physics, interaction of gamma radiation and charged particles with matter, nuclear detectors, particle accelerators, radioactivity, basic properties of nuclei, nuclear systematics, nuclear reactions, particle scattering, nuclear models of the deuteron, nuclear forces, parity. 3 units. *Weller*

308. Introduction to High-Energy Physics. High-energy processes; electromagnetic, weak, and strong interactions. Experimental instrumentation. 3 units. *Goshaw or Walker*

309. Solid-State Physics I. Properties of matter in the condensed state; crystal lattices, electrons in metals and semiconductors, band theory, nonmetallic solids, lattice dynamics, and phonons. Prerequisites: Physics 215 and 303. 3 units. *Palmer*

316. Principles of Quantum Theory. Original and fundamental concepts of quantum theory, wave and matrix mechanics, theory of measurements, exclusion principle, and electronic spin. Prerequisites: Physics 215 and 302. 3 units. *Biedenharn or Evans*

317. Intermediate Quantum Theory. General operator methods, angular momentum, Dirac electron theory. Second quantization; symmetry principles and conservation theorems. Applications to the theory of solids, of nuclei, and of elementary particles will be stressed. Prerequisite: Physics 316. 3 units. *Biedenharn or Evans*

318-319. Electromagnetic Field Theory. Electrodynamics, theory of wave optics, radiation of electric and magnetic multipole fields, special relativity, covariant electrodynamics, Lienard-Wiechert potentials, scattering and dispersion, Hamiltonian field equations. Prerequisite: Physics 182. 3 units each. *Robl*

331. Quantum Electronics.* Electromagnetic radiation and its interaction with matter. Lasers, nonlinear optics, submillimeter waves, detection theory, propagation. 3 units. *De Lucia*

333. Electronic Properties of Submicron Solid State Devices. Doping, disordering, and grading in heterojunctions and superlattices. MOCVD and MBE growth techniques. Physical properties of submicron electronic devices, high speed transport, mobility, energy band structure, and scattering processes. Classical and

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*Offered on demand.

quantum transport, quantum state transfer, control deformation of electron wave fur   , mobility modulation, and phonon dynamics. Two-dimensional electrons and plasmas. Monte Carlo simulation of submicron device performance. Current research and recent developments will be emphasized. C-L: Electrical Engineering 333. 3 units. *Stroscio*

335. Molecular Spectroscopy. Interpretation and theory of electronic, vibrational, rotational, and nuclear hyperfine states. Bound state quantum mechanics. Emphasis on small fundamental species of importance in science and technology. 3 units. *De Lucia*

342. Theory of Elementary Particles.* Theoretical methods used in treating particle interactions, emphasizing phenomenological treatments. Quantum field theory and dispersion theory is developed as needed. Applications in the general areas of pion physics, electromagnetic interactions of hadrons, strange particle interactions, and weak interactions are surveyed. Prerequisite: Physics 316. 3 units. *Han*

346. Topics in Theoretical Physics.* The content of this course will vary from year to year. General methods in quantum mechanics such as group theory and its applications, elementary particle theory, field theory, theory of solids, theoretical nuclear physics, atomic and molecular structure. Prerequisites: Physics 316 and 317. 3 units. *Staff*

COURSES CURRENTLY UNSCHEDULED

306. Low Temperature Physics

310. Solid-State Physics II

312. Phase Transitions and Critical Phenomena

330. Nuclear Structure Theory

341. Advanced Topics in Quantum Theory

343. Nuclear Physics

344. Advanced Nuclear Physics

345. High-Energy Physics

351, 352. Seminar

397, 398. Low Temperature and Solid-State Seminar

Physiology

Professor Johnson, *Chairman* (388 Nanaline H. Duke); Associate Professor Simon, *Director of Graduate Studies* (388 Nanaline H. Duke); Professors Blum, Diamond, Gutknecht, Jöbsis, Lieberman, Mandel, Moore, Reynolds, Somjen, Spach, and Tanford; Associate Professors Caron, N. Anderson, Bennett, C. Bonaventura, J. Bonaventura, Erickson, Greenfield, Kootsey, Kylstra, McManus, Mills, Padilla, Schomberg, and Wolbarsht; Assistant Professors P. A. W. Anderson, Camporesi, Dennis, Handwerger, Wallace, Wechsler, and Yarger; Adjunct Assistant Professor Carter; Associate Medical Research Professor Sylvia; Assistant Medical Research Professors Baumann and Hines

The Department of Physiology offers graduate work leading to the Ph.D. degree. Before undertaking this program a student should have a strong background in basic sciences including course work in mathematics, biology, physics, and chemistry through physical chemistry. Undergraduates with this background may have majors in any of the following areas: biology, chemistry, physics, mathe-

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*Offered on demand.

matics, engineering, or computer sciences. There is no foreign language requirement.

For Seniors and Graduates

200. Medical Physiology. Limited to students whose training requires knowledge of human physiology as it pertains to medicine. Four lectures, one conference, and one clinical correlation per week. Open to undergraduates only with consent of course leader. Fall. 4 units. *Padilla and staff*

202. Basic Neurobiology. An integrated interdepartmental course designed for first-year medical students and other professional and graduate students who need a core course on the morphology and functions of the mammalian nervous system. Lectures, laboratory demonstrations, clinical conferences, and lecture conferences during the month of January only. Prerequisites: ANA 305, ANA 307, BCH 200, and PHS 200 or equivalents. C-L: Anatomy 309. 4 units. *Hall, Kirshner, Somjen, and staff*

204. Introduction to Modern Physiology. Flow of fluids in tubes, ion transport mechanisms, and endocrine systems are examined in terms of how such processes enter into the functioning of intact organs such as heart, lung, gut, and central nervous system. Particular emphasis is given to the control of physiological function both at the cellular and higher levels of organization. Required of all graduate students in physiology. Others must have consent of instructor. Prerequisites: at least one year each of physics and calculus and biology; chemistry through organic chemistry; physical chemistry is strongly recommended. Spring. 4 units. *Blum and staff*

205. Design and Analysis of Biological Experiments. An introductory level course for individuals engaged in or planning research projects in the life sciences. Emphasis is on development of an adequate background in the fundamentals of probability, statistics, and hypothesis testing for application of these principles to commonly encountered research situations. The course will include lectures, hands-on use of the Statistical Analysis System (SAS) computer package for data analysis and critical evaluation of experimental designs employed in representative studies from the literature. 2 units. *Lobaugh*

208. Respiratory System in Health and Disease. Primary emphasis on the physiology of respiration. Topics include pulmonary mechanics; gas exchange; ventilation-perfusion relationships; central and peripheral regulation of ventilation and respiratory responses to exercise, altitude, and hyperbaric environments. Prerequisite: consent of instructor. Spring. 2 units. *Kylstra*

210. Individual Study. Directed reading and research in physiology. Prerequisite: consent of Director of Graduate Studies. 3 to 9 units each. *Staff*

217. Membrane Transport. Basic principles of the transport of water and solutes across biological and model membranes. The course uses physicochemical principles to provide a comprehensive understanding of phenomena such as active and passive transport, energy barriers through membranes, surface effects, and ion selectivity. The methodology and conceptual framework for the study of transport is described with selected examples from bilayers, red blood cells, nerve, and epithelia. Physical chemistry is recommended. Prerequisite: consent of instructor. Spring. 3 units. *Mandel*

230. Molecular and Cellular Bases of Differentiation. C-L: Anatomy 219, Biochemistry 219, Microbiology and Immunology 219, and Pathology 219. Fall. 3 units. *Padilla and staff*

280. Student Seminar in Physiology. Preparation and presentation of seminars to students and faculty on topics of broad interest to physiology. Required of all physiology students. 2 units. *Simon*

For Graduates

320. Gastrointestinal Physiology. The normal physiology, mechanisms of control, and transport characteristics of the gastrointestinal tract and its associated glands and organs (salivary, pancreas, liver) are presented. The mechanisms of secretion, reabsorption, and motility are treated at a cellular level. Numerous pathophysiological examples are presented and their clinical implications are emphasized. Spring. 2 units. *Akwari, Mandel, and staff*

321. Renal Physiology. Basic renal mechanisms involved in the elaboration of urine including concentrating and diluting mechanisms, hemodynamics, and regulation of acid-base balance. Both basic physiological processes and pathophysiological alterations will be considered. Spring. 2 units. *Dennis and staff*

350. Neurobiology of Diseases. Disorders of the nervous system will be discussed by panels of clinicians and basic scientists. Sessions will be divided into equal periods of clinical presentation, scientific analysis, and free discussion with student participation. Prerequisites: ANA 305, ANA 307, PHS 200, PHS 202, or equivalents. C-L: Pharmacology 350 and Pathology 350. Fall. 2 or 3 units. *Somjen and staff*

370. Neurobiology I. C-L: Pharmacology 370 and Anatomy 370. Taught alternate years in the fall semester. 3 units. *Kirshner and staff*

372. Research in Physiology. Laboratory investigation in various areas of physiology. Credit to be arranged. *Staff*

390. Membrane Biology. Various aspects of cell membranes and membrane proteins and lipids. Specific topics are chosen based on student interest and current literature discussed. Prerequisite: consent of instructor. Spring. 2 units. *Reynolds*

401. Metabolic Physiology. The control of gluconeogenesis, protein degradation, the storage and mobilization of glycogen and of lipids will be examined both at cellular level (e.g., metabolic compartmentation, futile cycling, enzyme modification) and in terms of interactions between tissues such as liver, kidney, and muscle. Strategies for metabolic adaptation to exercise, cold environment, starvation, obesity, and birth will be discussed. Prerequisites: Physiology 204 and one year of biochemistry. Taught in alternate years in the fall semester. 3 units. *Blum*

417. Cellular Endocrinology. Current concepts of the mechanisms of action of hormones at the cellular level, including hormone-receptor interactions, secondary messenger systems for hormones, mechanisms of regulation of hormone responsiveness, regulation of growth, differentiation and proliferation, cellular and electrophysiological mechanisms of secretory stimulus sensing and transduction, systems approach to feedback regulation and information transfer in an endocrine system. Lectures by local and outside clinical faculty will stress the clinical correlation of the basic concepts elaborated in the course. Students will be expected to participate in one seminar presentation. C-L: Pharmacology 417. Fall. 2 units. *N. Anderson, Caron, Padilla, and guest faculties*

418. Reproductive Biology. An in-depth study of male and female reproductive processes including hypothalamic, pituitary, and gonadal control mechanisms, as well as the physiology of pregnancy and parturition. Lectures by guest clinical faculty will emphasize the interface between basic science and clinical medicine.

The lecture material in each section of the course is followed by seminar presentations which will contribute to Physiology 424, a corequisite for the course. C-L: Anatomy 418. Spring. 2 units. *N. Anderson, Schomberg, and Tyrey*

424. Seminar in Reproductive Biology. Selected topics in reproductive biology will be chosen for in-depth reading and analysis in the seminar format. Can be taken independently or corequisite with Physiology 418. C-L: Anatomy 424. Spring. 1 unit. *N. Anderson, Schomberg, and Tyrey*

COURSES CURRENTLY UNSCHEDULED

203. Introduction to Biophysics and Biophysical Chemistry

207. The Heart in Health and Disease

281. Teaching in Physiology

301. Oxygen and Physiological Function

302. Advanced Topics and Research Seminar in Smooth and Striated Muscle

362. Cardiac Muscle Physiology

383. Physiological Instrumentation

416. Biophysics of Excitable Membranes

419. Topics in Mathematical Physiology

420. Cellular Immunophysiology

Political Science

Professor Kornberg, *Chairman* (214 Perkins); Associate Professor Lange, *Director of Graduate Studies* (331 Perkins); Professors Ascher, Barber, Bates, Braibanti, Fish, Holsti, Horowitz, Hough, Leach, Paletz, Price, Spragens, and Valenzuela; Associate Professors Eldridge, Johns, and McKean; Assistant Professors Booth, Canon, Entman, Gillespie, Grant, Grieco, Kitschelt, Lomperis, Roberts, Tsebelis, and Widner; Professors Emeriti Ball, Cleaveland, Cole, Grzybowski, Hall, Hallowell, Kulski, and Simpson; Adjunct Associate Professor O'Barr

The Department of Political Science offers graduate work leading to the A.M. and Ph.D. degrees. Before being admitted to candidacy for the Ph.D. degree, an applicant must have qualified for the A.M. degree.

Instruction is designed to prepare the student for teaching and research, for government service, and for other work related to public affairs. Before undertaking graduate study in political science, a student is ordinarily expected to have completed at least 12 semester hours of course work in political science. Instruction is currently offered in the following fields: American government and politics, comparative government and politics, political theory, and international relations.

The candidate for the degree of Doctor of Philosophy in political science must take at least sixteen courses in all, including twelve in the department, and demonstrate competence in at least two general fields of the discipline as well as in a third general field or in a specialized subfield or in a field external to the department. The candidate must also demonstrate a reading knowledge of two foreign languages or must demonstrate proficiency in one foreign language and in the use of statistics.

The terminal degree of Master of Arts, for those who do not intend to continue with doctoral studies, is awarded following successful completion of: (1) eight one-semester courses of 3 units each, at least half of which must be in political science; and (2) the A.M. thesis. In addition, candidates for the A.M.

degree must demonstrate competence in one foreign language or in statistics.

Further details on the graduate program in political science, the departmental facilities, the staff, and available financial aid may be obtained from the Director of Graduate Studies, Department of Political Science.

For Seniors and Graduates

201S. Problems in International Security. Major security issues. Prerequisite: a course in international relations or foreign policy. 3 units. *Staff*

203S. Politics and the Media of Mass Communication. Analysis of crucial aspects of the media-politics relationship. Media's effects on political socialization, public opinion, political participation, pluralism, power, and authority. Government's impact on the media. Prerequisite: consent of instructor. 3 units. *Paletz*

204S. Ethics in Political Life. Ethical issues arising in the conduct of political vocations and activities. C-L: Public Policy Studies 204S. 3 units. *Spragens*

207S. American Constitutional Interpretation. Development of the Constitution of the United States through Supreme Court decisions. 3 units. *Fish*

208S. Analyzing the News. C-L: Public Policy Studies 240S. 3 units. *Entman*

209. Problems in State Government and Politics. 3 units. *Leach*

211S. Current Problems and Issues in Japanese Politics. Sources of strength and weakness in the Japanese economy, the rise of new issues and strains in postindustrial society, changes in the party system and decision-making process, the possible transfer of power, the challenge of Japan's new world role. 3 units. *McKean*

212S. Domestic Structures and Foreign Policies of Advanced Democratic States. The influence of democratic institutions on the national-security and foreign-economic policies of advanced industrialized states. 3 units. *Grieco*

213S. Theories of International Political Economy. Comparison and assessment of traditional and modern theories in terms of their logical and empirical validity. 3 units. *Grieco*

214S. The Politics of Scarcity. Issues in politics, economics, ethics, and policy associated with conflicts arising from long-term scarcity in crucial resources. 3 units. *McKean*

215S. Philosophical Bases of Political Economy and Society. Central questions in the relationship between economy and society through an examination of the classical texts of political economy. Themes include: democracy and capitalism, the world economy and foreign policy, critiques of capitalism from the left and right. Readings drawn from Adam Smith, Karl Marx, J. M. Keynes, Joseph Schumpeter, Milton Freidman, and others. 3 units. *Booth*

216S. Evolution of European Marxism. The central themes in the evolution of European marxism: socialist thought prior to Marx; the writings of Marx and Engels. The themes are articulated in: Russian Marxism; Soviet communism and its Marxist critics; the rethinking of Marx's political economy, the theory of the state, and concepts of class consciousness in the works of twentieth-century European Marxists. 3 units. *Booth*

218S, 219S. Political Thought in the United States. 218S: the Founders and their European and Puritan antecedents; debates over slavery and the Union. 219S: topics in late nineteenth- and twentieth-century thought. 6 units. *Price*

220S. Problems in International Politics. Prerequisite: one course on international relations or foreign policy or diplomatic history. 3 units. *Holsti or Hough*

222. Seminar: Modern Political Classics. How social scientists think about politics. Works influential in shaping contemporary political science, written by political scientists, economists and sociologists. Topics include democracy, capitalism, socialism, voting, and collective action. 3 units. *Tsebelis*

223. Ancient Political Philosophy. Intensive analysis of the political philosophy of Plato, Aristotle, and other ancient theorists. 3 units. *Gillespie*

224S. Modern Political Theory. A historical survey and philosophical analysis of political theory from the beginning of the seventeenth to the middle of the nineteenth century. The rise of liberalism, the Age of Enlightenment, the romantic and conservative reaction, idealism, and utilitarianism. 3 units. *Spragens*

225. Topics in Comparative Government and Politics: Western Europe. Topics vary: the development of mass democracy and the welfare state; political and electoral participation and mobilization; social movements and political change; center-periphery conflicts; government and bureaucratic institutions and their relationships to society; the modern welfare state and political economy. 3 units. *Kitschelt or Lange*

226S. Theories of International Relations. An overview with applications to political-military and political-economic empirical problems. 3 units. *Grieco*

227. International Law. Theory and practice of international law: rights and duties of states with respect to recognition, state territory and jurisdiction, treaties, settlement of disputes, and other topics. 3 units. *Pye*

228S. Nineteenth- and Twentieth-Century Political Philosophy. Topics in nineteenth- and twentieth-century political philosophy, considering such authors as Hegel, Marx, Nietzsche, Dostoevski, Heidegger, Malraux, and Camus. 3 units. *Gillespie*

229S. Contemporary Theory of Liberal Democracy. Reading of major works and discussion of current issues in contemporary liberal and democratic theory. 3 units. *Spragens*

230. Introduction to Positive Political Theory. Basic concepts of political economy, theory of preference and choice, social choice theory, and decision and game theory. 3 units. *Tsebelis*

231. Crisis, Choice, and Change in Advanced Democratic States. Contribution of Marx, Weber, and Durkheim toward analysis of modern democracies. Examination of selected contemporary studies using these three perspectives to highlight processes of change and crisis. Unsettling effects of markets upon political systems, consequences of bureaucratic regulation, and transformation of sources of solidarity and integration in modern politics. 3 units. *Kitschelt*

232. Political Economy: Theory and Applications to Western Europe. This course will explore some basic theories of political economy at the individual, organizational and societal levels, drawing from Western Europe. Specific substantive topics will vary. 3 units. *Lange*

233S. Quantitative Political Analysis II. Intermediate statistical methods, especially linear regression, for political science research. Emphasis on assumptions and interpretations of results. Prerequisite: Political Science 138 or 236 or equivalent. 3 units. *Staff*

234S. Political Economy of Development: Theories of Change in the Third World. Alternative approaches to political, economic, and social change in Latin

America, Africa, and Asia. C-L: Anthropology 234S, History 234S, and Sociology 234S. 3 units. *Bergquist, Fox, Gereffi, Smith, and Valenzuela*

235S. Comparative Development of Islam. Comparative development of Islam in Indonesia, Malaysia, Pakistan, India, North Africa, and sub-Saharan Africa. A comparative analysis of the resurgence of Islam as a religious, political, and cultural force. 3 units. *Braibanti*

236. Statistical Analysis. Introduction to statistics in political research, emphasizing research design, descriptive and inferential statistics, and use of computers. Not open to students who have had or who are enrolled in Political Science 138, Economics 138, Mathematics 53 or 117, Psychology 117, Public Policy Studies 112 or 122, or Sociology 132 or 293. 3 units. *Staff*

237S. Comparative Public Policy. Introduction to methods, concepts, and theories of comparative public policy analysis. Substantive policies examined in the course vary each semester and may include economic, industrial, social, and civil rights policies. 3 units. *Kitschelt*

240. American Political Behavior. 3 units. *Staff*

242S. Comparative Law and Policy: Ethnic Group Relations. C-L: Public Policy Studies 242S and Law 572. 3 units. *Horowitz*

245. Ethics and Policy Making. C-L: Public Policy Studies 223. 3 units. *Price*

248. The Politics of the Policy Process. C-L: Public Policy Studies 219. 3 units. *Staff*

249. Comparative International Development and Technology Flow. Theoretical analysis of social, political, and economic development in Third World countries. The internal problem of maintaining political systems and the external problem of adapting intermediate or appropriate technologies. 3 units. *Braibanti*

251S. The American Presidency. The presidency and its impact on the American political system. 3 units. *Paletz*

252S. Seminar on Political Activists: Comparisons and Theories. Analysis of the importance of political activists for party strategies and electoral outcomes; sociological profile of activists, their motivations, and their beliefs. Comparison with theoretical conceptions concerning political parties. Three units. *Tsebelis*

253S. Comparative Government and the Study of Latin America. Current literature on major themes of Latin American politics. 3 units. *Valenzuela*

255. Political Sociology. C-L: Sociology 255. 3 units. *Smith, Stark, or Tiryakian*

256S. Arms Control and National Security Policy. The evolution of nuclear weapons and strategy and of global defense policy toward the Soviet Union and other adversaries; the arms control process and nonproliferation. Prerequisite: consent of instructor. 3 units. *Lomperis*

259S. Low Intensity Conflict and the Lessons of Viet Nam. The Viet Nam conflict and comparative cases; implications for Western interventions in the Third World. Prerequisite: consent of instructor. 3 units. *Lomperis*

260. The Tradition of Political Inquiry. Past and present problems, goals, presuppositions, and methods. 3 units. *Spragens*

261. Politics and the Future. The projection of possible political orders: the effects of changing resources, technologies, and values on mankind's ability to govern. 3 units. *Lomperis*

262S. International Communism. 3 units. *Hough*

263S. Methods of Political Science. The relation between theory and evidence; research designs for the comparative analyses of historical and statistical evidence. 3 units. *Roberts*

264. The President and the Federal Bureaucracy. Presidential management of the executive branch, including the development of the modern institutional presidency; an analysis of bureaucratic politics, its causes and effects; and an examination of executive-legislative relations in managing the bureaucracy. 3 units. *Staff*

267S. Policy Making in International Organizations. C-L: Public Policy Studies 267S. 3 units. *Ascher*

275. The American Party System. An intensive examination of selected facets of American national political parties, such as relationships between presidential and congressional politics, the politics of national conventions, recent foreign policy and party alignments, and the controversy over party government. 3 units. *Kornberg*

277. Comparative Party Politics. The impact of social and political systems on party structures, functions, ideologies, and leadership recruitment. Emphasis upon research techniques and objectives. 3 units. *Kornberg or Lange*

279S. Political Protest and Collective Mobilization. Survey of theories, methods, and empirical studies of political mobilization outside institutional channels; protest behavior and strategies; responses of the state to these challenges; the success of collective mobilization. Emphasis on comparative analyses of protest in advanced industrial democracies. 3 units. *Kitschelt*

282S. Canada. Topics vary each semester and may include nationalism in Canada, Canadian defense policies, Canadian-American relations, regionalism in Canada, environmental issues, and others. C-L: Anthropology 282S, History 282S, and Sociology 282S. 3 units. *Leach*

283S. Congressional Policy Making. Lawmaking and oversight of the executive branch by the United States Congress. Committee, party, executive, and interest group roles. C-L: Public Policy Studies 283S. 3 units. *Price*

284S. Public Policy Process in Developing Countries. C-L: Public Policy Studies 284S. 3 units. *Ascher*

286S. Judicial Administration. Organization, case processing, and management of courts with emphasis on federal appellate courts. Prerequisite: Political Science 127. 3 units. *Fish*

293. Federalism. Theoretical and operational aspects of federal systems of government, focusing on the United States and Canada. 3 units. *Leach*

For Graduates

303. Seminar on Statistics. Application of advanced statistical methods to political science research problems. Primary focus on multiple regression procedures. Emphasis on assumptions, interpretation of results, and use of the computer. Prerequisite: Political Science 236 or consent of instructor. 3 units. *Staff*

305. Seminar in U.S. Foreign Policy. Decision-making in American foreign policy. The sources, substance, and consequences of U.S. policy will be examined. The emphasis is on the period since 1945. 3 units. *Holsti*

306. Political Development of the U.S. Fourth Circuit Courts. A research seminar on federal trial and appellate courts, judges, and law: Maryland, Virginia, West Virginia, North and South Carolina, 1789-1958. C-L: Law 648. 3 units. *Fish*

308. Individual Research. Students will conduct research designed to evaluate hypotheses of their choice. Reports on the research must be presented in appropriate professional style. 3 units. *Staff*

309. Seminar in International Relations. Critical survey of theories and research in international relations and foreign policy. Emphasis will be placed on the interrelation between theory and research. 3 units. *Holsti*

321. Seminar in Political Theory. Prerequisites: 6 units in political science elected from 223, 224, 229, 231, or their equivalents. 3 units. *Spragens*

325. Seminar in Comparative Government and Politics. 3 units. *Staff*

326. Research Seminar in Comparative Government and Politics. Seminar in major issues in comparative politics and intensive individual student research projects. 3 units. *Staff*

332. Seminar on Political Economy: Micro Level. Survey of recent work in political science and economics on the organization of institutions: political, sociological, and economic. Focus upon the ways in which rational choice theory is applied to areas outside of economics. Three units. *Bates*

333. Seminar in Political Economy: Macro Level. Survey and analysis of recent work in political science, economics, and sociology on the relationships between states and markets. Special emphasis on the ways states influence market outcomes and the ways the organization of power in markets influences state behavior, especially in democratic systems. Three units. *Lange*

340. Seminar in American Politics and Institutions. Survey, analysis, and critique of the literature. 3 units. *Paletz or staff*

381. Research Seminar in Latin American Government and Politics. Prerequisite: Political Science 253 or equivalent. 3 units. *Valenzuela*

COURSES CURRENTLY UNSCHEDULED

280S. Comparative Government and Politics: Sub-Saharan Africa

360. Seminar in Government and Politics in the Soviet Union

RELATED COURSE WORK IN THE SCHOOL OF LAW

There may be graduate credit for course work completed in the Duke University School of Law, under regulations referred to in this bulletin under the section on academic regulations.

Psychology

Professor Staddon, *Chairman* (224 Psychology-Sociology); Professor C. Erickson, *Director of Graduate Studies* (225 Psychology-Sociology); Professors Alexander, Borstelmann, Carson, Coie, Costanzo, R. Erickson, W. G. Hall, Hasher, Lakin, Lockhead, M. Wallach, and Wing; Associate Professors Day, Eckerman, Holland, Roth, and Rubin; Assistant Professors Dix, Kremen, and Putallaz; Professors Emeriti Kimble and H. Schiffman; Adjunct Professors Brodie, Crovitz, W. C. Hall, Maddox, S. Schiffman, and Thompson; Adjunct Associate Professor Casseday

The department offers graduate work leading to the Ph.D. degree. The areas of concentration are biological, cognitive, and sensory sciences, personality, developmental, and clinical. A brochure is available from the Director of Graduate Studies which describes the program in more detail and gives information on financial assistance, facilities, and current research activities. The Psychology Department has no foreign language requirement.

200. Advanced Neuroscience I. Basic neuroanatomy and neurophysiology, physiology of the neuron and neural networks, neurotransmitter functions, sensory and motor systems. Fall semester. 3 units (4 with laboratory). *W. C. Hall and staff*

201. Advanced Neuroscience II. Integrative activities of the nervous system: sensory-motor relationships, neuroendocrine relationships, emotion and motivation, sleep, learning and memory, diseases of the nervous system and their psychological correlates. Spring semester. Prerequisite: Interdisciplinary Course/Psychology 200. 3 units (4 with laboratory). *W. Conner and staff*

203S. Sensation and Perception. Classical and current concepts and methods. 3 units. *Lockhead*

204S. Great Ideas in Psychology. Ideas in psychology drawn from various areas (perception, personality, motivation, biological bases, social, cognitive, developmental, learning, clinical) and various methodological approaches (experimental, introspection, observation, interview, longitudinal, simulation). Limited to junior/senior psychology majors and graduate students. 3 units. *Day*

210S. Cognition. Schematic view of cognitive psychology plus intensive study of two-three specific research topics such as forms of representation, individual differences, and problem solving models. Emphasis on alternative experimental and theoretical approaches. Prerequisite: Psychology 107 or graduate status. 3 units. *Day*

212S. Human Memory. Classical and modern literature, data, and theories relating to mechanisms of information processing, storage, and retrieval. 3 units. *Rubin*

214S. Development of Social Interaction. Major concepts and methods pertaining to early social development, emphasizing human social behavior and a developmental psychobiological approach. 3 units. *Eckerman*

215S. Cognitive Development. Major approaches to the development of knowledge, including Piaget, Thomas Kuhn, Vygotsky, Eleanor Gibson, Kohlberg, and others. 3 units. *L. Wallach*

216S. Biological Psychology. The neural basis of behavior with special emphasis on the localization of function. An historical approach, using original papers by Campbell, Lashley, Kluver, Schaefer, and Munk. While emphasis is on the neocortical sensory systems, the structure and function of the limbic system and hypothalamus are reviewed. C-L: Anatomy 216S. 3 units. *Diamond*

217S. Social Psychology. The psychology of interpersonal influence and control, the cognitive and social factors affecting the perception of persons and social action, the dynamics of interpersonal relations and relationship formation and change, the contribution of individual differences to social behavior, and application in environmental psychology, social psychology and law, and organizational psychology. 3 units. *Costanzo*

219S. Physiological Foundations of Psychology. Structure and function of the nervous system as related to problems of sensory-motor processes, learning, motivation, and memory. 3 units. *C. Erickson and R. Erickson*

220S. Psycholinguistics. Selected topics such as neurolinguistics, linguistic versus pictorial representation, individual differences, oral vs. written expression, language and personality, and the language-thought interaction. Prerequisite: Psychology 134 or graduate status. 3 units. *Day*

231S. Parent-Child Interaction. Examination of the empirical literature on parent-child interaction with emphasis on factors regulating parent behavior, individual differences in parenting, outcomes in children associated with different types of parenting, issues involved in compliance and internalization, and breakdown of normal parent-child behavior patterns. 3 units. *Dix*

234S. Personality. Selected topics of current interest concerning empirical research on personality. Strategies for the definition of research questions and the evaluation of research progress. 3 units. *M. Wallach*

238S. Electroencephalogram and Psychological Function. A survey of experimental and clinical literature on brain wave correlates of intelligence, personality, behavior disorders, epilepsy, sleep, sensory stimulation, reaction time, and attention. Emphasis on the electrophysiology of conditioning and learning. 3 units. *Marsh*

255S. Perinatal Behavior. Consideration of behavior patterns of animals and humans before and just after birth, their neural organization, and the way that they are influenced by experience. 3 units. *W. G. Hall*

261S. Modern Learning Theory. The relation of modern viewpoints on the learning process to traditional ones; topics include animal and human learning. 3 units. *Holland*

266S. Comparative Neurobiology. The evolution and functional organization of the vertebrate brain. A study of the original papers of the pioneers in comparative anatomy. C-L: Anatomy 266S. 3 units. *Diamond and W. C. Hall*

267S. Brain Mechanisms of Behavior. General physiological principles of brain organization in relation to behavioral processes from sensation to concept formation. Discussions of original readings from seminal papers in the early nineteenth century to the present. 3 units. *R. Erickson*

270S. A-R. Selected Problems. New courses not yet in the bulletin are designated as 170S or 270S depending on level. Since all faculty offer these courses, their contents vary accordingly. Different courses indicated by the letter. 3 credits. *Staff*

272S. Physiology of the Central Nervous System. The central processing of sensory information, motor control, ions and electric activity in the central nervous system, and pathologic changes of function; an intensive advanced seminar. Prerequisite: consent of instructor. C-L: Physiology 272S. Students may take the course for half or one course credit. For one course credit, additional papers are required. 2 or 3 units. *Somjen and staff*

273S. Statistical Principles in Experimental Design. The problems of scientific inference; methods of data analysis and issues in experimental design. 3 units. *Roth*

285S. Developmental Psychobiology. The development of motivation, learning, and reward mechanisms and their neurobiological basis. Animal studies and some human work. 3 units. *W. G. Hall*

286S. Biological Basis of Hearing. Anatomy and physiology of the auditory system; neural mechanisms for localization of sound, frequency discrimination, and discrimination of temporal patterns of sound such as speech; disorders of hearing. 3 units. *Casseday*

289S. Psychology of Prevention. Concepts of prevention and mental health promotion; community psychology and social systems; epidemiology and prediction of disorder; intervention strategies; evaluation of prevention trials; and ethical and cultural issues. 3 units. *Coie*

For Graduates

301. Group Psychotherapy and Group Influence Processes. Theories of group interventions and group techniques. 3 units. *Lakin*

302S. Personality Theory. An advanced course in the representative theories of human functioning, from Freud to contemporary approaches. 3 units. *Kremen*

305. Psychopathology. An examination of behavior disorders, with particular emphasis on explanatory concepts and the evidence from research in this field. 3 units. *Carson*

307. Introduction to Theories and Methods of Mainstream Psychotherapies. Application of personality theories to therapeutic change processes. Problems of therapy case management. 3 units. *Carson or Lakin*

309. Seminar in Learning. Selected topics in operant conditioning and discrimination learning. 3 units. *Staddon*

310. Seminar in Perception. 3 units. *Lockhead*

318. Measurement and Methods. Examination of relationships among ideas, methods, and measures in psychological and social research. 3 units. *Sheppard*

319-320. Research Apprenticeship I. Individualized research training with a faculty mentor. 6 units. *Staff*

323, 324. Seminar in Community Psychology. An examination of the organization and functioning of community systems and an exploration of factors involved in system changes through psychologically based intervention strategies. On-line experiences with school system consultation will provide a primary basis for study. 3 units each. *Alexander or Costanzo*

329-330. Proseminar in Psychology. A historically oriented, team-taught course introducing graduate students to important ideas and discoveries in scientific psychology. 6 units. *Staff*

331-332. Research Apprenticeship II. Individualized research training with a faculty mentor. 6 units. *Staff*

335-336. Personality Assessment. First semester: Personality assessment through interviews and the study of personal documents. Second semester: Personality assessment through the study of formal tests, objective and projective. 6 units. *Alexander and staff*

343-344. Clinical Practicum. Intensive experience and supervision in clinical intervention processes. Student training in psychotherapy strategies and techniques and in clinical consultation skills is conducted in clinical settings. 6 units. *Staff*

348. Psychotherapy with Children and Families. Major theoretical approaches to clinical intervention with children and adolescents, either individually or in the family system context. 3 units. *Coie*

349-350. Practicum in Psychological Research. 6 units. *Staff*

351. Developmental Psychopathology. Consideration of major psychopathological disorders in childhood and adolescence, theories and research on etiology and prediction of disorder. 3 units. *Lochman and Thompson*

352. Child Assessment. Interview methods; intelligence and achievement testing; personality and developmental batteries; peer, teacher, and parental instruments; and observational techniques. 3 units. *Coie and Putallaz*

353. Research Practicum in Prevention. Students will be involved in a short-term research apprenticeship to a faculty member other than their mentor for

hands-on experience with research efforts pertinent to the prevention of illness. 3 units. *Staff*

398. Graded Research. 1 to 3 units. *Staff*

399. Special Readings in Psychology. 3 units. *Staff*

COURSES CURRENTLY UNSCHEDULED

230S. Social Behavior of Animals

337. Seminar in Sensory Discrimination

Public Policy Studies

Professor Cook, *Director* (109C Old Chemistry); Associate Professor McConahay, *Director of Graduate Studies* (219A Old Chemistry); Professors Ascher, Barber (political science), Clotfelter, Eddy, Fleishman (School of Law), Gillis, Horowitz (School of Law), Hough (political science), Ladd, Pearsall (engineering), and Price (political science); Associate Professors Behn, Kuniholm, Lipscomb, Magat (Fuqua School of Business), and Stack; Assistant Professors Entman and Shetty; Professors of the Practice Geller, Stubbing, and Yaggy; Instructors Durning and Widner; Lecturer Payne

The graduate program in public policy studies is offered through the Institute of Policy Sciences and Public Affairs. The objective of the program is to prepare students for jobs, particularly in the public sector, which require analytical skills and a practical understanding of the processes by which policy is made and implemented.

The A.M. degree requires two academic years and a summer internship. The first year is devoted to core courses in policy analysis, including sequences in quantitative methods, economics, political analysis, and ethics. The summer internship is arranged with a federal, state, or local agency. The second-year curriculum includes course work in public management and macroeconomics, a concentration in a substantive policy area, and a master's "memo" to be researched and written on a problem of current policy concern.

Students who are concurrently enrolled in a Ph.D. program or a professional degree program (M.D., J.D., M.B.A., M.H.A., etc.), or who have already obtained such a degree, can apply for an abbreviated version of the A.M. program. Such students are excused from most second-year requirements, so ordinarily the A.M. in public policy can be completed in one additional year. Students usually apply for a joint degree program simultaneously with their applications to the graduate departments or professional schools, or during their first or second year of advanced study.

The institute does not award a Ph.D.

More information concerning the A.M. programs can be obtained by writing the Director of Graduate Studies.

For Seniors and Graduates

204S. Ethics in Political Life. C-L: Political Science 204S. 3 units. *Spragens*

215S. Public Policies to Save Lives. Economic, political, legal, and ethical issues in governmental efforts to reduce mortality through various health and safety programs and regulations. 3 units. *Staff*

217. Microeconomics and Public Policy Making. Consumption and production theory, welfare economics, theories of collective choice, market structures and regulation, and nonmarket decision making. 3 units. *Clotfelter*

218. Macroeconomic Policy. Survey of macroeconomic theory and analysis of policies designed to reduce unemployment, stimulate economic growth, and stabilize prices. Conventional monetary and fiscal instruments, employment policies, and new policies designed to combat inflation. C-L: Economics 218. 3 units. *Staff*

219. The Politics of the Policy Process. The formulation of public policies, substantive policies in a variety of contexts from local government to international affairs; the role of legislatures, interest groups, chief executives, and the bureaucracy in defining alternatives and in shaping policy from agenda formulation to implementation. (Not open to students who have taken Public Policy Studies 114.) C-L: Political Science 248. 3 units. *Entman*

221. Analytical Methods I: Decision Analysis for Public Policy Makers. Methods for structuring decision dilemmas and decomposing complex problems, assessing the probabilities of uncertain consequences of alternative decisions, appraising the decision maker's preferences for these consequences and for re-examining the decision. (Not open to students who have taken Public Policy Studies 55.) 3 units. *Behn or Lipscomb*

222. Analytical Methods II: Data Analysis for Public Policy Makers. Sampling theory, Bayesian statistics, and regression analysis. Examples from problems in health care, transportation, crime, urban affairs, and politics. (Not open to students who have taken Public Policy Studies 112.) 3 units. *McConahay*

223. Ethics and Policy Making. Normative concepts in politics, liberty, justice, the public interest: historical and philosophical roots, relationship to one another and to American political tradition, and implications for domestic policy problems. C-L: Political Science 245. 3 units. *Kuniholm or Price*

231. Analytical Methods III: Quantitative Policy Evaluation. Problems in quantifying policy target variables such as unemployment, crime, and poverty. Experimental and nonexperimental methods for evaluating the effect of public programs, including topics in experimental design, regression analysis, and simulation. Prerequisite: Public Policy Studies 222 or equivalent. 3 units. *McConahay*

232. Analytical Methods IV: Topics in Economic Policy. Cost benefit analysis of public programs. Public utility regulation, pollution regulation, hospital rate setting, regulation of product safety. Quantitative methods and microeconomic theory for analysis of both normative and positive aspects of economic policy. Prerequisites: Public Policy Studies 110 or 217 or Economics 149 and familiarity with regression analysis or concurrent enrollment in Public Policy Studies 231. C-L: Economics 232. 3 units. *Gillis*

236S, 237S. Public Management I and II: Managing Public Agencies. 236S: operations management, information and performance, personnel management, public sector marketing. 237S: organizational strategy, organizational structure and design, leadership and motivation, labor negotiations. Prerequisite for 237S: Public Policy Studies 236S. 3 units each. *Behn, Durning, or Yaggy*

238S. Public Budgeting and Financial Management. Fund accounting for government; techniques of financial analysis, including break-even analysis, cost accounting, cash-flow analysis, and capital budgeting; and governmental budgeting, including the budgetary process and reforms, and the budget crunch in the public sector. 3 units. *Behn or Stubbing*

240S. Analyzing the News. Research seminar on political messages and effects of media. Methods and findings of content analysis, survey research, critical theory, semiology; research project integrating these approaches. C-L: Political Science 208S. 3 units. *Entman*

241. Reporting the American People. Critical analysis of the sources of information the media rely upon in reporting opinion and policy preferences: opinion polls, bellwethers, informed elites. Includes the design and execution of a public opinion poll on a topic of local or national interest. 3 units. *McConahay*

245S. Leadership Tutorial. Analysis of techniques, personal qualities, and organizational factors that help or hinder effective leadership. Practical experience in evaluation of leadership efforts. Prerequisite: consent of instructor. 3 units. *Payne*

250S. Policy, Philanthropy, and the Arts. Democratic and aesthetic values in relation to past and present patterns of public, corporate, and philanthropic support for the arts. The uses of art criticism and political theory in evaluating subsidies, grants, tax incentives, and censorship. Prerequisite: consent of instructor. 3 units. *Payne*

254. Transportation Planning and Policy Analysis. C-L: Civil and Environmental Engineering 216. Prerequisite or corequisite: Civil and Environmental Engineering 116 or consent of instructor. 3 units. *Pas*

257. United States Policy in the Middle East. From World War II to the present with a focus on current policy options. 3 units. *Kuniholm*

264S. Research Seminar: Topics in Public Policy I. Selected topics. 3 units. *Staff*

267S. Policy Making in International Organizations. Emphasis on international financial institutions such as the World Bank and the International Monetary Fund. C-L: Political Science 267S. 3 units. *Ascher*

268. Federal Tax Policy. Structure, incidence, and economic effects of major federal taxes. Special attention to problems of inflation, income definition, distortions, savings, and investment. C-L: Economics 268 and Law 518. 3 units. *Clotfelter or Schmalbeck*

270S. Humanistic Perspectives on Public Policy. Modes of inquiry into aspects of social life important to policy makers but beyond the normal reach of social science. Reading from James Agee, Robert Coles, Eudora Welty, James Baldwin, George Eliot, and others. Prerequisite: consent of instructor. 3 units. *Coles and Payne*

272. Resource Economics and Policy. See C-L: Forestry and Environmental Studies 270. 4 units. *Hyde*

278. Human Service Bureaucracies. Schools, prisons, courts, welfare agencies: decision-making, implementation, the impact of work practices on clients. The future of street-level bureaucracy. 3 units. *Stack*

283S. Congressional Policy Making. C-L: Political Science 283S. 3 units. *Price*

284S. Public Policy Process in Developing Countries. Policy-making patterns in less developed countries; examples from Latin America, Africa, and Asia. C-L: Political Science 284S. 3 units. *Ascher*

286S. Economic Policy Making in Developing Countries. Fiscal, monetary, and exchange rate policies in less developed countries; issues in public policy toward natural resources and state-owned enterprises. Prerequisite: Public Policy Studies 110 or Economics 149, or consent of instructor. C-L: Economics 286S. 3 units. *Gillis*

290. Glasgow Seminar in Public Policy. The large theoretical problems of public policy (e.g., justice, equality, liberty); the making and implementation of policy in specific areas (e.g., economic, urban, social); comparative analysis of

Europe's communist countries and how their political systems differ from those of the United States and Britain. Taught in Scotland. 3 units. *Staff*

For Graduates

303. Public Policy Workshop I. Introduction to policy analysis and advising. Emphasis on written and oral communication skills, the substance of public policies, and the role of policy analysts. Open to Public Policy Studies A.M. students only. 3 units. *Behn or Durning*

304.01. Public Policy Workshop II. The role and influence of policy analysis. The examination of specific public policy cases and recommendations for action. Emphasis on written and oral communications skills. 3 units. *Behn or Durning*

305.01. Public Policy Workshop III. Emphasis on individual or group projects. Preparation for Masters Memo. Open to Public Policy Studies A.M. students only. 3 units. *Yaggy*

387. Research Tutorial in Public Policy. 3 units. *Staff*

388. Research Tutorial in Public Policy. 3 units. *Staff*

399. Special Readings in Public Policy Studies. 3 units. *Staff*

COURSES CURRENTLY UNSCHEDULED

256. The Economics of Health Care

270S. Humanistic Perspectives on Public Policy

Religion

Associate Professor Bland, *Chairman* (117B Gray); Professor Hauerwas, *Director of Graduate Studies* (209A Divinity School); Professors D. Campbell, Clark, Herzog, Kort, Lacy, Langford, Lawrence, Lincoln, Long, Marsden, E. Meyers, Murphy, Osborn, Poteat, D. M. Smith, H. Smith, Steinmetz, Via, Wainwright, and Wintermute; Associate Professors Bailey, Corless, Gregg, C. Meyers, Partin, and Peters; Assistant Professors T. Campbell and Robinson; Adjunct Professor Sasson

The Department of Religion offers graduate work leading to the A.M. and Ph.D. degrees. Students may major in one of seven fields: (1) Old Testament and Semitic studies, (2) New Testament and Christian origins, (3) history of Christianity, (4) Christian theology and ethics, (5) history of Judaism, (6) history of religions, and (7) religion and culture. They will be expected to take courses which will contribute to an adequate understanding of their chosen fields of specialization and will be required to take two written preliminary examinations within their field of concentration.

In addition to course work in their major field, students will take such other courses in cognate fields as will contribute to the enrichment of their major studies and will be required to take one written preliminary examination in a single cognate area within the department. A minor requirement may be fulfilled by work in a cognate department, such as classical studies, history, philosophy, political science, or sociology, and will constitute the outside minor and material for a fourth written preliminary examination. There is, in addition, an oral examination conducted by the student's committee immediately subsequent to the written examinations. There is a foreign language requirement of two languages which must be met before taking the doctoral preliminary examination.

The program of doctoral studies presumes a foundation in the academic study of religion. Students applying for graduate work in religion directly from an undergraduate program should have had a strong undergraduate major in religion,

and will be accepted for the Ph.D. program only upon the satisfactory completion of the A.M. degree with the department.

The graduate program also offers an A.M. degree that is not linked to a specific Ph.D. field. Such study is intended to encourage individuals to pursue a variety of interests irrespective of whether they desire further graduate study. An A.M. concentration may be in any of the seven Ph.D. fields or in an individually designed program of study (such as Islamic studies or religion and the social sciences).

For Seniors and Graduates

200. Person and Work of Christ. The problem of knowledge of Christ and formulation of a doctrine of his work and person in the light of biblical eschatology. 3 units. *Staff*

204. Origen. The systematic and apologetic writings of an important Alexandrian thinker and exegete of the third century. 3 units. *Gregg*

205. War and the Christian Tradition. An analysis of how Christians have understood and evaluated war, with particular attention to the question of the moral status of war. Works by Augustine, Aquinas, Bainton, Ramsey, Childress, Niebuhr, and Johnson will be considered. 3 units. *Hauerwas*

206. Christian Mysticism in the Middle Ages. 3 units. *Gregg*

207, 208. Intermediate Biblical Hebrew. Grammar with reading and exegesis of Old Testament prose and poetry. Prerequisite: at least one year of Hebrew or consent of instructor. C-L: Old Testament 207, 208 in the Divinity School. 6 units. *Staff*

209. Old Testament Theology. Studies of the Old Testament in regard to theological themes and content. 3 units. *Murphy*

213. Christian Ethics in America. Ethical thought in America since Rauschenbusch. 3 units. *Hauerwas*

215S. Theological Ethics. Philosophical paradigms and the nature of the Christian life. 3 units. *Hauerwas*

217. Islam in India. History and thought of major Indian Muslims from Biruni to Wali-Ullah, with special attention to the role of Sufism. An introduction to selected Muslim scholars and saints who contributed to the interaction between Islam and Hinduism in northern India during the second millennium A.D. 3 units. *Lawrence*

218. Religion in Japan. A survey of religion in Japan, with special emphasis on indigenization and attempts at synthesis. An approach to the meaning of the words *religious* and *secular* in the Japanese situation. 3 units. *Corless*

219. Augustine. The religion of the Bishop of Hippo in late antiquity. C-L: Medieval and Renaissance Studies. 3 units. *Clark*

220. Rabbinic Hebrew. Interpretive study of late Hebrew, with readings from the Mishnah and Jewish liturgy. 3 units. *E. Meyers or staff*

223A-E. Exegesis of the Hebrew Old Testament. 3 units each.
A. Pentateuch. *Staff*
B. Historical Books. *Staff*
C. Major Prophets. *Staff*
D. Minor Prophets. *Staff*
E. Writings. *Staff*

225. Living Issues in New Testament Theology. Critical examination of major problems and issues in New Testament interpretation and theology. 3 units. *Via*

226A-F. Exegesis of the Greek New Testament I. 3 units each.
A. Matthew. *Via*
B. Romans. *Staff*
C. Mark. *Via*
E. The Gospel and Epistles of John. *D. M. Smith*
F. I and II Corinthians. *D. M. Smith*

227A-D. Exegesis of the Greek New Testament II. 3 units each.
A. Luke. *Staff*
B. Galatians. *D. M. Smith*
C. The Pastoral Epistles. *Staff*
D. Epistles of Peter and James. *Staff*
E. Acts. *M. Smith*

228. Twentieth-Century Continental Theology. An investigation of leading theologians and theological trends. 3 units. *Osborn*

230S. The Meaning of Religious Language. An analysis of the credentials of some typical claims of theism in the light of theories of meaning in recent thought. C-L: Philosophy 230S. 3 units. *Poteat*

231S. Seminar in Religion and Contemporary Thought. Analytical reading and discussion of such critical cultural analysis as is found in the works of Polanyi, Arendt, Trilling, and others, with appraisal of the relevance of theological inquiry. 3 units. *Poteat*

232S. Religion and Literature. Theories concerning the relation of religion to literary forms, particularly narrative. 3 units. *Kort*

233. Modern Narratives and Religious Meanings. A study of kinds of religious meaning or significance in representative American, British, and Continental fiction of the first half of the twentieth century. 3 units. *Kort*

234. Early Christian Asceticism. The development of asceticism and monasticism in the first six centuries of Christianity. C-L: Women's Studies. 3 units. *Clark*

235. Heresy: Theological and Social Dimensions of Early Christian Dissent. 3 units. *Clark*

236. Luther and the Reformation in Germany. The theology of Martin Luther in the context of competing visions of reform. C-L: Medieval and Renaissance Studies. 3 units. *Steinmetz*

237. History of the Ancient Near East. Emphasis upon the religions, literature, and art of Mesopotamia. 3 units. *Bailey*

238. Jewish Responses to Christianity. Apologetic and polemical themes in rabbinic, medieval, and contemporary writings. 3 units. *Bland*

239. Introduction to Middle Egyptian I. Grammar and readings in hieroglyphic texts relating to the Old Testament. 3 units. *Wintermute*

240. Introduction to Middle Egyptian II. Readings in Middle Egyptian and introduction to New Egyptian Grammar. Prerequisite: Religion 239. 3 units. *Wintermute*

243. Archaeology of Palestine in Biblical Times. Investigation of selected material remains from the Bronze Age to the Persian period. Trends in biblical studies, with particular attention to methodological considerations and current developments. 3 units. *C. Meyers*

244. The Archaeology of Palestine in Hellenistic-Roman Times. The study of material and epigraphic remains as they relate to Judaism in Hellenistic-Roman times, with special emphasis on Jewish art. 3 units. *C. Meyers or E. Meyers*

245. Ethics in World Religions. Moral foundations, assumptions, and applications in such major faiths as Hinduism, Buddhism, Confucianism, and Islam, in the light of Christian ethical perspectives. 3 units. *Lacy*

246. Problems in Historical Theology. Prerequisite: consent of instructor. 3 units. *Staff*

248. The Theology of Karl Barth. A historical and critical study of the theology of Karl Barth. Prerequisite: consent of instructor. 3 units. *Osborn*

249. The Lord's Prayer. Introduction to God, man, prayer, and kingdom through historical and contemporary expositions of the Lord's Prayer. 3 units. *Wainwright*

256. John Wesley in Controversial and Ecumenical Theology. A study of John Wesley and his theology: his engagements with other confessional traditions, and his views on such matters as church, ministry, sacraments, and authority. Relation to contemporary theology, especially "Faith and Order." 3 units. *Wainwright*

257. New Testament Ethics. Scope and basic problems of New Testament ethics; consideration of two important New Testament books. Problems and issues such as the role of the law, symbolic language in ethical discourse, conscience, homosexuality, the state, and self deception. 3 units. *Via*

258. Coptic. Introduction to the Sahidic dialect with selected readings from Christian and Gnostic texts. Prerequisite: at least one year of Greek. 3 units. *Wintermute*

259. Icon Theology. A study of theological controversies surrounding the use of images in Christian worship, followed by an attempt to perceive the symbolic conventions and doctrinal content of some Eastern, Western, and contemporary icons. 3 units. *Wainwright*

262. Marxist Ideology and Christian Faith. Comparative examination of Communist and Christian doctrines concerning humans, society, sin, history, and eschatology, together with an introduction to the contemporary dialogue. 3 units. *Lacy*

263. Third World Theology. An examination of selected theological writings from Asia, Africa, and Latin America, comparing their perspectives and their unique contributions with contemporary Christian thought. 3 units. *Lacy*

264. The Sociology of the Black Church. An effort to identify, define, describe, and interpret the black church. 3 units. *Lincoln*

265. The Religions of the West Africa Diaspora. Religious development of Africans displaced to the Western Hemisphere by slavery. 3 units. *Lincoln*

266. Ethics and Health Care. 3 units. *H. Smith*

267. American Puritan Thought through Edwards. Study of some of the classic investigations of American Puritan thought, culminating with a more intensive look at literature by and about Jonathan Edwards. 3 units. *Marsden*

268. Revelation and Authority in the Church. A critical and constructive examination of contemporary concepts. 3 units. *H. Smith*

269. Feminist Theory and the Humanities. C-L: English 283 and Women's Studies. 3 units. *Clark, Orr, Pope, or Tompkins*

270. American Evangelism and Fundamentalism. A study of some of the major themes in the development of transdenominational evangelicalism and fundamentalism in America from the eighteenth century to the present. This will be a reading seminar involving analyses and discussions of literature (mostly secondary works) important for understanding American evangelicalism as a distinct movement. 3 units. *Marsden*

279. Understandings of the Resurrection in Contemporary Thought. Recent literature on the resurrection of Jesus Christ from the perspectives of exegesis, historical criticism, hermeneutics, and systematic significance. 3 units. *Wainwright*

280. The History of Religions. A study of the methodology of the history of religions, the nature of religious experience, and specific categories of religious phenomena. 3 units. *Partin*

281. Phenomenology and Religion. The writing of Scheler, E. Strauss, Merleau-Ponty, Ricoeur, Binswanger, or others; their bearing upon religious knowledge and practice. Prerequisite: consent of instructor. 3 units. *Poteat*

282. Myth and Ritual. Myths, rites, and symbols as modes of religious expression. Interpretation of symbolic configurations of kingship, initiation, sacrifice, and pilgrimage in diverse cultural contexts. 3 units. *Robinson and staff*

283. Islam and Modernism. Cultural, religious, and ideological forces which shape Muslim responses to modernism. 3 units. *Lawrence*

284. The Religion and History of Islam. Origins and development of the Islamic community and tradition, with particular attention to the religious element. 3 units. *Partin*

285. Introduction to the History of Religions. The history, symbols, rites, and structures of the manifestations of the sacred in the major religious traditions of the world. 3 units. *Staff*

287. The Scriptures of Asia. Translations of basic texts from the religious traditions of India, China, and Japan. 3 units. *Staff*

288. Buddhist Thought and Practice. A historical introduction to Buddhist thought and practice, with special attention to their interrelationship in the living religion. 3 units. *Corless*

289. Theology and Contemporary Secular Understandings of Human Nature. Critical theological examination of selected current interpretations of human nature and the human situation. 3 units. *Langford*

290. Current Problems in Christian Social Ethics. A critical study of secularization, the technological revolution, and the ecological crisis. 3 units. *Staff*

291. Historical Forms of Protestant Ethics. A survey of major types of Protestant ethical theory from Luther through contemporary figures. 3 units. *Staff*

292. Happiness, Virtue, and Friendship. Issues of their relationship in moral philosophy. 3 units. *Hauerwas*

294. Christianity and the State. The relation of the Christian theory of the state to political problems, with special consideration of the religious assumptions underlying democratic theory and practice and of the relationship of church to state. 3 units. *Staff*

For Graduates

300. Systematic Theology. Method and structure of systematic theology, the doctrine of God, theological anthropology, and Christology. 3 units. *Herzog*

302. Studies in the Intertestamental Literature. Selected documents of the Apocrypha and Pseudepigrapha examined exegetically and theologically in their relation to postexilic Judaism. Prerequisite: consent of instructor. 3 units. *Staff*

304. Aramaic. A study of the Aramaic portions of the Old Testament and selected passages from the Elephantine and Qumran texts. 3 units. *E. Meyers or Wintermute*

304A. Targumic Aramaic. An introduction to the language and literature of the Aramaic translations of the Old Testament. 3 units. *Meyers*

305. The Septuagint. A study of the modern critical use of the Greek Old Testament. Prerequisites: knowledge of Greek and Hebrew. 3 units. *Peters*

306. Language and Literature of the Dead Sea Scrolls. A study in interpretation. Prerequisite: a knowledge of Hebrew. 3 units. *Staff*

307. Syriac. A study of the script and grammar, with readings from the Syriac New Testament and other early Christian documents. Prerequisite: some knowledge of Hebrew and Aramaic. 3 units. *Staff*

308. Greek Patristic Texts. Critical translation and study of selected Greek texts illustrative of significant aspects of patristic theology and history from the second through the fifth century A.D. 3 units. *Staff*

309. Hermeneutics. Consideration of the nature of understanding and of several interpretive methods—such as phenomenological, existential, historical, literary, structural—along with their application to New Testament texts, primarily the parables of Jesus. 3 units. *Via*

310. Readings in Judaica. Selected studies in Jewish material culture and problems in Jewish religious and intellectual history. 3 units. *Bland, E. Meyers, and staff*

316S. History of Religions. Selected problems in the field. 3 units. *Long*

318. Seminar in the Greek Fathers. A study of selected topics from the Greek Fathers. 3 units. *Gregg*

322. Nineteenth-Century European Theology. Protestant theology from Kant to Herrmann. 3 units. *Herzog*

323A. Comparative Semitic I. An introduction to the morphology and syntax of classical Ethiopic and the Semitic languages of Mesopotamia, together with a consideration of their relationship to Hebrew. 3 units. *Wintermute*

323B. Comparative Semitic II. An introduction to the morphology and syntax of classical Arabic and the Semitic languages of Palestine-Syria, together with a consideration of their relationship to Hebrew. 3 units. *Wintermute*

325. Philosophical Theology I. Theology, as the knowledge of God, considered in dialogue with selected pagan and Christian philosophers from Plato to Kant. 3 units. *Staff*

326. Philosophical Theology II. Continuation of Philosophical Theology I. 3 units. *Langford*

329. Readings in Theology and Language. Sample treatments of religious language in linguistic analysis, hermeneutical theory, literary criticism, liturgical practice, and fundamental theology. 3 units. *Wainwright*

330. Contemporary Christologies. A seminar dealing with contemporary Roman Catholic and Protestant Christology. Readings and discussion will focus on theological proposals from major contemporary figures. 3 units. *Wainwright*

331. Eschatology. A study of issues in individual, communal, and universal eschatology against the background of twentieth-century scholarly work on the kingdom of God. 3 units. *Wainwright*

332. System in Theology. An examination of the various factors that go into the shaping of a systematic theology, followed by a study of several recent and contemporary examples of the genre. 3 units. *Wainwright*

333. The Doctrine of the Trinity. Biblical bases, patristic developments, contemporary statements and connections. 3 units. *Wainwright*

334. Theology and Reform in the Later Middle Ages. The life and thought of the medieval church from the twelfth century through the fifteenth. Popular and academic theologians from Pierre Abelard to Gabriel Biel. 3 units. *Steinmetz*

335. The English Church in the Eighteenth Century. Studies of Christianity in England from the Act of Toleration, 1689, to the death of John Wesley, 1791. 3 units. *T. Campbell*

337. Theology of St. Thomas Aquinas. Intensive reading of the *Summa Theologica* and biblical commentaries. 3 units. *Staff*

338. Calvin and the Reformed Tradition. The theological development of John Calvin. A comprehensive examination of his mature position with constant reference to the theology of other reformers. C-L: Medieval and Renaissance Studies. 3 units. *Steinmetz*

339. The Radical Reformation. Protestant movements of dissent in the 16th century. Special attention will be devoted to Müntzer, Carlstadt, Hubmaier, Schwenckfeld, Denck, Marpeck, Socinus, and Menno Simons. 3 units. *Steinmetz*

340, 341. Seminar in the New Testament. Research and discussion on a selected problem in the biblical field. Spring only. 3 units each. *Staff*

343. Readings in Ancient Near Eastern Wisdom Literature. A survey of the principal Egyptian and Mesopotamian works that relate to biblical wisdom. 3 units. *Murphy*

346. Practical Reason and Personal Identity: Explorations in Narrative. This course will deal with questions of the nature of rationality in morality and theology and attend particularly to those suggestions about narrative as the form of such rationality. The readings will involve works by Frei, Ricoeur, Goldberg, MacIntyre, and McClendon, as well as work in literary criticism. 3 units. *Hauerwas*

350, 351. Old Testament Seminar. Research and discussion on selected problems in the Old Testament and related fields. Fall only. 3 units each. *Staff*

352. Seminar in Christian Theology. Research and discussion of a selected problem in the systematic field. 3 units. *Staff*

353. Seminar on Text Criticism. Emphasis upon transmission, versions, apparatus, and method. Prerequisite: reading knowledge of Hebrew and Greek. 3 units. *Bailey*

360. Special Problems in Religion and Culture. Intensive investigation of the relations of religion and modernity, using seminal contemporary texts. Topics announced each semester. Prerequisite: consent of instructor. 3 units. *Poteat*

362. Readings in Old Testament and Semitic Studies. Selected studies in the Hebrew Bible and the languages and literatures of the ancient Near East. 3 units. *Staff*

363. Readings in New Testament and Christian Origins. Selected studies on a theme in modern New Testament scholarship. 3 units. *Staff*

364. Readings in History of Christianity. Selected issues in the social, material, and intellectual history of Christianity. 3 units. *Staff*

365. Readings in Christian Theology and Ethics. An examination of selected topics of historical and contemporary interest in these fields. 3 units. *Staff*

366. Readings in History of Religions. Selected studies in cross-cultural and intercreedal material, together with assessment of the problems they pose for the study of religion. 3 units. *Staff*

367. Readings in Religion and Culture. Analysis and discussion of theories and of individual research projects. 3 units. *Staff*

373-374. Elementary Akkadian. Study of the elements of Akkadian grammar. Reading of neo-Assyrian texts shedding light on the Old Testament. Prerequisite: biblical Hebrew. 6 units. *Bailey*

380. Existentialist Thought. An exploration of the interests and motifs of existentialism in relation to modern philosophy and theology through an analysis of representative writings of Kierkegaard, Heidegger, Berdyaev, Marcel, and Sartre. 3 units. *Poteat*

383. Moral Theology in the Twentieth Century. Critical and comparative examination of ethical theory as exhibited in the work of selected contemporary theologians. 3 units. *H. Smith*

384. Religious Dissent in American Culture. History and significance of dissent in the theology and culture of America. 3 units. *Staff*

385. Religion in American Literature. A critical study of the meaning and value of religious motifs reflected in American literature. 3 units. *Staff*

386. Christianity in Dialogue with Other Faiths. Contemporary currents of Christian thought as they affect resurgent non-Christian faiths, new formulations of a theology of mission, and ecumenical conversations. 3 units. *Lacy*

387. Ethical Method. Selected methodological issues in contemporary theological ethics. 3 units. *H. Smith*

389. Christian Ethics and Contemporary Culture. A study of the interaction between Christian thought and current social theory. 3 units. *Staff*

395. Christian Thought in Colonial America. Exposition of the main currents in Protestant theology. 3 units. *Staff*

396. Liberal Traditions in American Theology. A study of the main types of modern religious thought, beginning with the theology of the Enlightenment. 3 units. *Staff*

COURSES CURRENTLY UNSCHEDULED

210. Contemporary British Theology

221. Readings in Hebrew Biblical Commentaries

241. Problems in Reformation Theology

242. Life after Death in Semitic Thought

247. Readings in Latin Theological Literature

251. Counter-Reformation and Development of Catholic Dogma

252. Nineteenth- and Twentieth-Century Roman Catholic Theology

301. Seminar in Contemporary Christian Ethics

311. Pharisaic Judaism in the First Century

312. Pauline Theology

313. The Apostolic Fathers

314. Judaism and Christianity in the New Testament

317. Seminar in the Greek Apologists

319. The Gospel According to Saint Matthew in Recent Research

320. Theology, Power, and Justice

324. Readings in the History of Religion

327. Philosophical Method in Religious Studies

328. Twentieth-Century European Theology

344. Zwingli and the Origins of Reformed Theology

388. Ethics and Medicine

397. Contemporary American Theology

398. Colloquium on the Teaching of Religion

401. Colloquium on Biblical Studies

Romance Languages

Professor Fein, *Chairman* (205 Languages); Associate Professor Thomas, *Director of Graduate Studies* (214 Languages); Professors Garci-Gómez, Jameson, Osuna, Stewart, Tetel, and Wardropper; Associate Professors Caserta, Hull, Kaplan, Orr, and Pérez; Assistant Professors Bell and Ross; Visiting Professor Dorfman

The Department of Romance Languages offers graduate work leading to the A.M. and Ph.D. degrees in French and Spanish. Requirements for the A.M. may be completed by submission of a thesis or by passing a comprehensive examination in the major field. Related work for the A.M. and Ph.D. degrees is required in a second Romance language or in any one or two of a number of other subject areas. A reading knowledge of one foreign language which is outside the major language is required.

In order to undertake graduate study in Romance languages, the entering student should have credit for at least 18 semester hours (or equivalent) above the intermediate level in the major language.

FRENCH

For Seniors and Graduates

200S. Seminar in French Literature. Topics to be announced. 3 units. *Staff*

210. The Structure of French. Modern French phonology, morphology, and syntax. Readings in current linguistic theory. 3 units. *Hull*

211. History of the French Language. The evolution of French from Latin to its present form; internal developments and external influences. C-L: Medieval and Renaissance Studies. 3 units. *Hull*

223. Semiotics for Literature. A study of theoretical writings in general semiotics by Frege, Peirce, Saussure, Mukarovsky, Morris, and their applications for textual analysis of French literary works by representative contemporary critics such as Eco, Riffaterre, Corti, and Greimas. In English. 3 units. *Thomas*

248. French Literature of the Seventeenth Century. The baroque and the classical: form and meaning in the plays of Corneille, Racine, and Moliere. Readings in baroque and précieux poetry. C-L: Medieval and Renaissance Studies. 3 units. *Staff*

251, 252. Literature of the Eighteenth Century. Problems of literary history, critical reading, and interpretation, focused on varying topics. 6 units. *Stewart*

255. French Preromantic and Romantic Poetry. Chénier, Vigny, Lamartine, Musset, Hugo, and Nerval. 3 units. *Orr*

256. Modern Literature and History. The problems of history, society, and politics in literature, through the writings of Rousseau, Tocqueville, Michelet, Flaubert, Hugo, Merleau-Ponty, Foucault, and others. 3 units. *Orr*

257. Problems of Identity in the Nineteenth-Century Novel. Romanticism and romantic realism, studied especially in the works of Chateaubriand, Stendhal, Constant, de Staël, and Sand. 3 units. *Bell, Jameson, or Orr*

258. The Narrative of Social Crisis. Realism and naturalism, with special emphasis on Balzac, Flaubert, and Zola. 3 units. *Bell, Jameson, or Orr*

261. French Symbolism. Poetry and theories of Baudelaire, Mallarmé, and Rimbaud. Decadence: Lautréamont and Laforgue. 3 units. *Thomas*

263. Contemporary French Theater. Dramatic theory; the art of the leading directors; the major texts of Claudel, Anouilh, Sartre, Beckett, Ionesco, Genet, Adamov, Arrabal, and Rezvani. 3 units. *Orr or Thomas*

264. Contemporary French Poetry. The language of poetry. A chronological and theoretical approach to the major poets and movements since 1950. Selections from Bonnefoy, Char, Daive, Deguy, Dupin, Jabès, Jaccottet, Faye, Guillevic, Michaux, Meschonnic, Noël, Oulipo, Ponge, Stefan, Tortel, and others. 3 units. *Orr or Thomas*

265. French Literature of the Early Twentieth Century. Emphasis on Gide, Mauriac, Proust, and Colette. 3 units. *Kaplan*

266. French Literature of the Mid-Twentieth Century. Emphasis on Malraux, Sartre, Camus, and the *nouveau roman*. 3 units. *Jameson*

290S. Studies in a Contemporary Figure. A writer, philosopher, critic, or artist. 3 units. *Staff*

For Graduates

325. French Prose of the Sixteenth Century. Rabelais, Marguerite de Navarre, Montaigne, and others. C-L: Medieval and Renaissance Studies. 3 units. *Tetel*

326. Topics in Renaissance Poetry. C-L: Medieval and Renaissance Studies. 3 units. *Tetel*

391, 392. French Seminar. 3 units. *Bell, Jameson, Orr, Stewart, Tetel, and Thomas*

Graduate Reading Course. An intensive course in French to develop rapidly the ability to read French in several fields. Graduate students only. No credit.

ITALIAN

For Seniors and Graduates

283. Italian Novel of the Novecento. Representative novelists from Svevo to the most recent writers. 3 units. *Caserta*

284. Dante. *La Vita Nuova* and a close reading of the *Inferno.* Conducted in English. C-L: Medieval and Renaissance Studies. 3 units. *Caserta*

285. Dante. The *Purgatorio* and the *Paradiso* in the light of Dante's cultural world. Special attention will be given to the poetic significance of the *Commedia.* Prerequisite: Italian 284 or equivalent. C-L: Medieval and Renaissance Studies. 3 units. *Caserta*

SPANISH

For Seniors and Graduates

200S. Seminar in Spanish Literature. Topics to be announced. 3 units. *Staff*

210. History of the Spanish Language. Formation and development of Spanish: internal forces and external contributions. C-L: Medieval and Renaissance Studies. 3 units. *Garci-Gómez*

241. Colonial Prose of Spanish America. Narrative forms written in Spanish America during the sixteenth, seventeenth, and eighteenth centuries. 3 units. *Ross*

242. Colonial Poetry and Theater of Spanish America. The expression of Renaissance and Baroque styles in the Hispanic New World, including works of Sor Juana, Ruiz de Alarcón, Ercilla, and others. 3 units. *Ross*

245. Modern Spanish-American Poetry. From *modernismo* to the present. 3 units. *Fein*

246. Modern Spanish-American Fiction. Twentieth-Century novels and short stories by Borges, Carpentier, Cortázar, Gallegos, García Márquez, Quiroga, and others. 3 units. *Pérez*

248. Studies in Spanish-American Literature. Concentration on single authors, genres, movements, or themes. 3 units. *Staff*

251. The Origins of Spanish Prose Fiction. Selected examples of the romance and the novel: *Amadís de Gaula*, Diego de San Pedro's *La Cárcel de amor,* the *Abencerraje*, the *Lazarillo*, Montemajor's *Diana.* C-L: Medieval and Renaissance Studies. 3 units. *Wardropper*

253. Cervantes. The life and works of Cervantes, with special emphasis on his *Quijote.* C-L: Medieval and Renaissance Studies. 3 units. *Wardropper*

254. Drama of the Golden Age. The chief Spanish dramatists of the seventeenth century with readings of representative plays of this period. C-L: Medieval and Renaissance Studies. 3 units. *Wardropper*

258S. Spanish Lyric Poetry before 1700. A critical study, based on close reading and discussion, of selected poems of the Middle Ages, Renaissance, and baroque. Special emphasis on the *Razón de amor, la Poesía de tipo tradicional,* and Santillana; on Garcilaso, San Juan de la Cruz, Fray Luis de León, and Herrera; on Góngora and Quevedo. C-L: Medieval and Renaissance Studies. 3 units. *Wardropper*

262. The Romantic Movement. Principal manifestations of romanticism in Hispanic literature; poetry (Bécquer, Espronceda, Rosalía de Castro), drama (Rivas, Zorrilla), and the novel (Issacs, Mármol). 3 units. *Pérez*

275. Modern Spanish Poetry. Juan Ramón Jiménez, Unamuno, Antonio Machado, the Generation of 1927, and the contemporary poets. 3 units. *Osuna*

276. Modern Spanish Drama. The theater of Benavente, Valle-Inclán, Lorca, Casona, Buero Vallejo, Sastre, and Arrabal. 3 units. *Osuna*

277. Modern Spanish Novel. From the Generation of 1898 to the present. 3 units. *Osuna*

For Graduates

391, 392. Hispanic Seminar. Each semester one of the following topics will be selected for intensive treatment: the Spanish language in America, studies in medieval literature, studies in the literature of the Golden Age, studies in Latin American literature, studies in the Spanish Renaissance and baroque, studies in Spanish poetry, studies in nineteenth-century Spanish literature, and studies in twentieth-century literature. C-L: Medieval and Renaissance Studies. 6 units. *Fein, Garci-Gómez, Osuna, Pérez, Wardropper*

ROMANCE LANGUAGES

218. The Teaching of Romance Languages. Evaluation of objectives and methods; practical problems of language teaching at the elementary, secondary, and college levels; analysis of textbooks, texts, and audiovisual aids; applied linguistics. 3 units. *Hull*

310. Computers for the Humanities. Applications of computers in three major humanistic areas: *(a)* textual research—concordances, stylistic analysis, critical editing; *(b)* text processing; and *(c)* computer-assisted or computer-managed instruction in the humanistic disciplines. No prior training in computing is required. Theoretical lectures and programming practicum. 3 units. *Thomas*

Slavic Languages and Literatures

Professor Krynski, *Chairman* (314 Languages); Associate Professor Emeritus Jezierski

The Department of Slavic Languages and Literatures offers graduate courses in Russian language and literature and limited training in the language and literature of Poland.

Students should have sufficient preparation in the Russian language to enable them to read Russian classical literature in the original. Any presently unscheduled course will be taught in any semester upon request.

For Seniors and Graduates

201, 202. Russian Novel of the Nineteenth Century. 201: 1830 to 1870. 202: 1870 to 1900. Prerequisites: Russian 161 and 162 or equivalents. 6 units. *Krynski*

225. Tolstoy. *War and Peace* and other works. Prerequisite: Russian 175S or equivalent. 3 units. *Jezierski*

232. Dostoevsky. Emphasis on *Brothers Karamazov* and the theory of the novel. Prerequisite: Russian 176 or equivalent. 3 units. *Jezierski*

COURSES CURRENTLY UNSCHEDULED

230. Chekhov

Sociology

Professor Land, *Chairman* (268 Sociology-Psychology); Professor Smith, *Director of Graduate Studies* (332 Sociology-Psychology); Professors Back, Kerckhoff, Maddox, Myers, Palmore, Simpson, and Tiryakian; Associate Professors George, Gereffi, Spenner, and Wilson; Assistant Professor O'Rand; Professors Emeriti McKinney and Preiss; Research Professor Manton

The department offers graduate work leading to the A.M. and Ph.D. degrees in sociology. Students beginning work toward an advanced degree should have completed a minimum of 12 semester hours of acceptable courses in sociology and an additional 12 semester hours in related work (e.g., other social sciences, statistics, computer science, philosophy, mathematics). Accepted applicants who have not had such preparation may be required to take work beyond the usual requirements. Applicants for admission are required to take the verbal and quantitative aptitude tests of the Graduate Record Examination.

The Ph.D. program requires the student to take three core courses (Sociology 206, 207, 208) and a major and a minor specialization. Specializations (with the associated proseminar indicated in parentheses) include Life Course and Aging Studies (Sociology 221); Comparative and Historical Sociology (Sociology 222); Criminology, Criminal Justice, and the Sociology of Law (Sociology 223); Demography, Ecology, and Social Epidemiology (Sociology 224); and Organizations, Markets, and Work (Sociology 225). Requirements for major specialties vary between five and seven courses. Minor specialities require three or more courses. Including the two courses outside the department required by the Graduate School, a student entering with only an undergraduate degree and adequate course preparation would need to take a minimum of from thirteen to fifteen courses to satisfy degree requirements. Up to fifteen credits, the equivalent of five courses, may be transferred for graduate work taken elsewhere, with requirements adjusted as appropriate.

There is a qualifying procedure after three semesters, or the equivalent, to determine whether the student can proceed to the preliminary examination. The latter consists of a four hour written examination covering the student's chosen major and minor specializations and a two hour oral examination covering these areas plus the core material. Further details concerning the general departmental program, the specialities and their requirements, departmental facilities, the faculty, ongoing research, and stipends available may be obtained from the Director of Graduate Studies.

For Seniors and Graduates

200S. Exile and Frontiers: Finding a Definition of Home for the Twentieth-Century. Exile in its past and present literary, political, anthropological, religious, and social dimensions; the way in which contemporary situations (transnationalization, identity crisis, emergence of liberation and community movements, cold war politics) give a special significance to exile today. Prerequisite: consent of instructor. C-L: IDC 215S and Political Science 241S. 3 units. *Dorfman*

206. Sociological Theory. Structure, foundations, and historical antecedents of recent formulations of such theoretical approaches as phenomenological sociology, exchange theory, critical theory, structuralism, neo-Marxist sociology, sociobiology, and action theory. 3 units. *Tiryakian or Wilson*

207. Social Statistics I: Basic Concepts and Methods. Review of descriptive statistics; probability concepts; statistical inference, t-tests and the analysis of variance. Bivariate correlation and regression, dummy variables, multiple regression, and the analysis of covariance. Stress on applications. Statistical computing using SPSS and other programs. 3 units. *Land, Manton, or Spenner*

208. Survey Research Methods. Theory and application of survey research techniques in the social sciences. Sampling, measurement, questionnaire construction and distribution, pretesting and post-testing, response effects, validity and reliability, scaling of data, data reduction and analysis. Prerequisite: Sociology 207 or the equivalent. 3 units. *Back, Kerckhoff, or Smith*

211A-E. Proseminars in Sociological Theory. Development of sociological thought, systematic sociological theory, interrelations with other social and behavioral sciences. 3 units. *Tiryakian or Wilson*

    A. Background of Sociology
    B. Formal Aspects of Theory
    C. Sociology of Knowledge
    D. Evolutionary Theory and Sociobiology
    E. Special Topics in Sociological Theory

212. Social Statistics II: Linear Models, Path Analysis, and Structural Equation Systems. Model specification, review of simple regression, the Gauss-Markov theorem, multiple regression in matrix form, ordinary and generalized least squares, residual and influence analysis. Path analysis, recursive and nonrecursive structural equation models; measurement errors and unobserved variables. Application of statistical computing packages. Prerequisite: Sociology 207 or equivalent. 3 units. *Land, Manton, or Spenner*

213. Social Statistics III: Discrete Multivariate Models. Assumptions, estimation, testing, and parameter interpretation for the log-linear, logit, logistic, and probit models. Model comparisons, application of statistical computing packages and programs. Prerequisite: Sociology 212 or equivalent. 3 units. *Land, Manton, or Spenner*

214. Comparative and Historical Methods. Scope, methods, and controversies of comparative and historical sociology. 3 units. *Gereffi, Smith, or Tiryakian*

215. Basic Demographic Methods and Materials. Population composition, change, and distribution. Methods of standardizing and decomposing rates, life tables and population models, analysis of data from advanced and developing countries. Applications of computer programs for demographic analysis. Prerequisite: Sociology 207 or equivalent. 3 units. *Manton or Myers*

216. Advanced Methods of Demographic Analysis. Theory and estimation methods for life tables. Reproductivity, the stable population model. Graduation, interpolation, and other data adjustments for faulty data. Hazards models. Prerequisite: Sociology 215 or equivalent. 3 units. *Land or Manton*

217A-F. Proseminars in Social Statistics and Research Methods. Selected topics in the collection and analysis of social science data. 3 units. *Back, Gereffi, Land, Manton, Myers, Smith, Spenner, or Tiryakian*

    A. Discrete and Continuous Models of Measurement
    B. Hazards Models, Event History Analysis, and Panel Data
    C. Dynamic Model and Times Series Analysis
    D. Research Design
    E. Evaluation Research Methods
    F. Special Topics in Social Statistics and Research Methods

221A-D. Proseminars in Aging and Life Course Analysis. Selected topics in socialization, human development, status attainment and careers, and the sociology of aging. 3 units. *Back, George, Kerckhoff, Land, Maddox, Manton, Myers, O'Rand, Palmore, or Spenner*

    A. Social Structure and the Life Course
    B. Social Patterns of Personal Development
    C. Social Gerontology
    D. Special Topics in Aging and Life Course Analysis

222A-D. Proseminars in Comparative and Historical Sociology. Selected topics in the differentiation and transformation of societies. 3 units. *Gereffi, Kerckhoff, Maddox, Myers, Simpson, Smith, or Tiryakian*

A. Theories of Social Change
B. Comparative Aspects of Societal Transformation
C. Theories of Change in Third World
D. Special Topics in Comparative and Historical Sociology

223A-E. Proseminars in Criminology, Criminal Justice, and the Sociology of Law. Selected topics in crime and the institutions of social control. 3 units. *Land, Simpson, Tiryakian, or Wilson*
A. Theories of Crime Causation
B. Human Development and Criminal Careers
C. Social Control and the Criminal Justice System
D. Sociology of Law
E. Special Topics in Criminology, Criminal Justice, and the Sociology of Law

224A-F. Proseminars in Demography, Human Ecology, and Social Epidemiology. Selected topics in population studies. 3 units. *Back, Land, Maddox, Manton, Myers, or Smith*
A. Population Dynamics
B. Mortality and Morbidity
C. Urbanization and Migration
D. Social Epidemiology
E. Population and Health Care Systems
F. Special Topics in Demography, Human Ecology, and Social Epidemiology

225A-E. Proseminars in Organization, Markets, and Work. Selected topics in complex organizations, the labor process, and changing occupations. 3 units. *Gereffi, Kerckhoff, Land, Maddox, O'Rand, Simpson, Smith, Spenner, or Wilson*
A. Organizations and Environments
B. The Social Psychology of Organizations
C. Markets and Market Behavior
D. Careers and Labor Markets
E. Special Topics in Organizations, Markets, and Work

226A-H. Proseminars in Social Institutions and Processes. Selected topics in the sociology of institutions and social and institutional behavior. 3 units. *Back, George, Kerckhoff, Maddox, O'Rand, Smith, Spenner, Tiryakian, or Wilson*
A. Social Psychology
B. Social Stratification
C. Political Sociology
D. Sociology of Religion
E. Sociology of Science
F. Sociology of Education
G. Medical Sociology
H. Special Topics in Social Institutions and Processes

234S. Political Economy of Development: Theories of Change in the Third World. C-L: Anthropology 234S, History 234S, and Political Science 234S. 3 units. *Bergquist, Fox, Gereffi, C. Smith, or Valenzuela*

255. Political Sociology. Pluralist, elite, and class theories of the relationship between state and society. Topics include: recent debates on the welfare state, social control, political participation, and state-society relations in socialist economies. C-L: Political Science 255. 3 units. *Smith or Tiryakian*

282S. Canada. C-L: Anthropology 282S, History 282S, and Political Science 282S. 3 units. *Staff and visitors*

298S, 299S. Seminar in Selected Topics. Substantive, theoretical, or methodological topics. 3 units each. *Staff*

The University Program in Toxicology

Professor of Pathology Graham, *Director* (M255 Davison Building); Professor Abou-Donia, *Deputy Director* (020 Research Park IV); Professor Fridovich, *Deputy Director* (231 Nanaline Duke Building); Associate Professor Richardson, *Deputy Director* (004A Biological Sciences Building); Professor Adams, *Director of Graduate Studies* (M310-B Davison Building)

The University Program in Toxicology seeks to produce individuals with sound training in the scientific basis for research in toxicology who will advance the science of this discipline. After broad general courses in epidemiology and statistics, pathology, and mammalian toxicology, students will be trained in one of three tracks: (1) as generalist toxicologists, with broad training in the principles and concepts of toxicology and the design of protocols for toxicological assessments; (2) as specialist toxicologists in those areas of toxicology research in which faculty members are currently productive in pulmonary toxicology, neurotoxicology, immunotoxicology, genetic toxicology (carcinogenesis), and biochemical toxicology; or (3) as ecotoxicologists with broad training in principles and concepts of both toxicology and ecology as they relate to the release, transport, exposure, accumulation, and the effects of toxicants in the ecosystem.

The toxicology program faculty is comprised of members from the Departments of Anesthesiology, Biochemistry, Chemistry, Medicine, Microbiology and Immunology, Pathology, Pharmacology, Physiology, Zoology, and the School of Forestry and Environmental Studies.

Students seeking the Ph.D. in one of the participating Graduate School departments may make initial application to either the program or one of the departments. All who apply directly to the program will be considered for admission by the program and the department of the student's choice. Students who apply initially for graduate study in one of the departments may also be nominated by that department for admission to the program. It is expected that most students will have a strong undergraduate preparation in mathematics and the physical and biological sciences with demonstrated excellence of performance as judged by grades in course work and letters of recommendation from former instructors.

Each student in the program will take a series of courses in toxicology as well as courses specified by his or her department. A student will be expected to choose a dissertation adviser in his or her department at least by the end of the first two semesters in the program, and will normally be expected to begin dissertation research during the third semester in residence. Upon satisfactorily completing all degree requirements in the program and in the department, students will be jointly recommended for the Ph.D. degree.

Further information may be obtained from the Director of the Toxicology Program.

Women's Studies

Jean F. O'Barr, *Director* (207 East Duke Building); Carol Meyers, *Associate Director*

The Women's Studies Program provides a focal point within the university for the study of gender. Students enrolled in any of the university's departments and professional schools may participate in the program through enrollment in the courses listed below, through specialized study in independent research with any of the fifty-four faculty members associated with the program, and through pursuing an M.A. or Ph.D. thesis topic in feminist theory. Students considering a concentration in women's studies are encouraged to consult the Director for assistance in tailoring a program of study suited to their individual professional needs.

SIGNS: Journal of Women in Culture and Society is edited at Duke. Internships and work-study positions form an important part of the graduate education of students interested in feminist scholarship.

IDC 211. History of Feminist Thought. The intellectual history of feminist thought and an analysis of the sex/gender system from medieval through modern times. Examination of classical philosophical, sociological, and literary texts. 3 units. *Neuschel, J. O'Barr, or Pope*

IDC 283. Feminist Theory and the Humanities. Beliefs about gender in the assumptions, methods, and central issues, as well as the principal subject matter, of mainstream scholarship in traditional humanities disciplines. Consideration will be given to the way particular social and institutional circumstances linked to gender distinctions have, historically, lent the disciplines their particular character and traditional concerns. 3 units. C-L: English 283, Religion 269, and Women's Studies. *Clark, Orr, Pope, or Tompkins*

IDC 284. Feminist Theory and the Social Sciences. Examination of feminist modes of inquiry in the social sciences. The relationship of gender in economic, political, social, and cultural systems and the resulting methodological shifts in social science disciplines. C-L: History 284. 3 units. *Chafe, Neuschel, O'Rand, C. Smith, or Spenner*

COURSES ON WOMEN OFFERED BY DEPARTMENTS

Anthropology 215. The Anthropology of Women. *Staff*
Anthropology 220S. The Cultural Construction of Gender. *Quinn*
Anthropology 241. The Rise of Civilization in Mesopotamia and Iran. *Zagarell*
Anthropology 272. Marxism and Feminism. *Smith*
Anthropology 280. American Marriage: A Cultural Approach. *Quinn*
Comparative Literature 282. Structuralism, Poststructuralism and After. *Tompkins*
Comparative Literature 289. Topics in Feminist Theory. *Staff*
English 269. American Women Writers. *Tompkins*
English 353. Novels of E.M. Forster and Virginia Woolf. *Mellown*
English 287. Feminist Literary Theory. *Pope*
French 290. Studies in a Contemporary Figure: Wittig. *Orr*
History 227, 228. Recent United States History: Major Political and Social Movements. *Chafe*
History 351.40. Colloquium in Women's History. *Scott*
Literature 302. New Criticism in Literary Theory. *Staff*
Political Science 200A. Contemporary American Feminism. *J. O'Barr*
Public Policy Studies 264. Women and Justice. *Stack*
Religion 234. Early Christian Asceticism. *Clark*
Romance Languages 391. French Prose of the 16th Century: Marguerite de Navaree. *Tetel*
Sociology 277. Social Patterns of Personal Development. *Kerckhoff and O'Rand*

Zoology

Professor Gillham, *Chairman* (227 Biological Sciences); Associate Professor Rausher, *Director of Graduate Studies* (226 Biological Sciences); Professors Barber, Costlow, Fluke, Klopfer, Livingstone, McClay, Nicklas, Staddon, Tucker, Vogel, Wainwright, Ward, and H. Wilbur; Associate Professors Forward, Laurie-Ahlberg, Lundberg, H. Nijhout, Ruderman, Sutherland, and Uyenoyama; Assistant Professors Conner and Roth; Lecturer M. Nijhout, Professors Emeriti Bailey, Bookhout, Gregg, Schmidt-Nielsen, and K. Wilbur; Adjunct Professor Schmidt-Koenig

The Department of Zoology manages a variety of programs tailored to individual needs of students seeking the Ph.D. degree. The A.M. degree may be taken by students en route to the Ph.D., or by those who leave the doctoral program. Ordinarily, only students seeking the doctorate are admitted to the department.

In general, students entering the department will be equipped to pursue advanced degrees if they have completed an undergraduate major in biology along with some formal training in college level chemistry, mathematics, physics, and foreign languages. A reading knowledge of one foreign language is required of all doctoral students in zoology.

Nevertheless, in recognition and support of the modern trend toward interdisciplinary research, the department is prepared to accept promising students with less orthodox academic backgrounds and is ready to encourage any student wishing to undertake a program of study leading, in effect, to an interdisciplinary degree sponsored by the department.

Thus, all students are urged to search widely in both the *Bulletin of Duke University: Undergraduate Instruction* and the *Bulletin of Duke University: Graduate School* for information about the intellectual resources of the University. Special attention should be given to announcements of the Departments of Anatomy, Anthropology, Biochemistry, Botany, Chemistry, Geology, History, Mathematics, Microbiology and Immunology, Pharmacology, Philosophy, Physiology, Psychology, Sociology, and Zoology; announcements of the Schools of Engineering and Forestry and Environmental Studies should also be consulted.

For Seniors and Graduates

The *L* suffix on a zoology course number indicates that the course includes a laboratory.

201L. Animal Behavior. Survey of past developments and current controversies in animal behavior. Extensive readings, followed by individual experimental or descriptive projects in the laboratory or field (or Primate Center). Recommended background: Zoology 74L, Zoology 151L, and Mathematics 117, or equivalents. 4 units. *Klopfer*

203L. Marine Ecology. Application of ecological theory to marine systems. Mathematical properties of population growth and species interactions; field and laboratory projects with computer-assisted analysis of data. Practice in scientific writing. Readings from current scientific publications. Prerequisites: introductory biology or invertebrate zoology and calculus; knowledge of statistics recommended. Offered at Beaufort. C-L: Marine Sciences 203L. 6 units. *Sutherland*

204L. Community Ecology. Mechanisms that determine the distribution and abundance of plants and animals: geology, climate, physiography, soils, competition, predation, and history. Lectures focus on ecological principles. Seminars and weekend field trips. Prerequisites: an introductory ecology course and consent of instructor. C-L: Botany 267L. 4 units. *Christensen (botany) and Wilbur*

206S. Controversies in Biology. A contentious theme for reading, discussion, and an individual or joint paper. Illustrative past topics: the nature of the creative process, causality in biological thought, the lack of political impact of many scientific developments. Open to nonmajors. 3 units. *Klopfer*

215L. Primary Productivity in the Seas. Prerequisites: introductory biology and chemistry. Offered at Beaufort. C-L: Botany 215L. 4 units. *Barber and Ramus*

216L. Limnology. Lakes, ponds, and streams: their origin, development, geochemistry, energy balance, productivity, and the dynamics of plant and animal communities. Laboratory includes field trips. Offered biennially. Prerequisites:

introductory biology and Chemistry 12 and physics and Mathematics 32 or consent of instructor. 4 units. *Livingstone*

222L. Entomology. The biology of insects: diversity, development, physiology, and ecology. Field trips. Prerequisite: introductory biology. 4 units. *H. Nijhout*

226L. Ichthyology. Diversity, evolution, natural history, and ecology of fishes. Laboratory includes overnight field trips to marine and freshwater habitats. Prerequisites: introductory biology and Zoology 108L or equivalent. 3 units. *Lundberg*

233. Principles of Insect Behavior. Processes governing the behavior of animals as illustrated by insects. Neural integration, communication, genetics, ecology, and evolution of individual and social behavior. Invertebrate zoology or entomology recommended. 3 units. *Conner and Rausher*

237L. Systematic Biology. Theory and practice of identification, species discovery, phylogeny reconstruction, classification, and nomenclature. Prerequisites: introductory biology and one course in animal or plant diversity. C-L: Botany 237L. 3 units. *Lundberg and Mishler (botany)*

244. Principles of Immunology. Prerequisites: Zoology 160 and Chemistry 151 or consent of instructor. C-L: Microbiology 244. 3 units. *Amos, McClay, and staff*

245S. Radiation Biology. The biological effects of ionizing radiations: classical concepts in the context of recent research papers. Analytical uses of radiation. Prerequisites: introductory biology, Chemistry 11, 12, and Physics 51, 52. 3 units. *Fluke*

247S. Photobiology. Effects of visible light and of ultraviolet and near ultraviolet radiation in living systems: repair processes, quantum processes, physical optics. Prerequisites: college physics and introductory biology. 3 units. *Fluke*

249. Biomechanics. Principles of fluid and solid mechanics applied to biological systems. Prerequisites: Physics 51 and Mathematics 31 or equivalents. 3 units. *Vogel and Wainwright*

250L. Physiology of Marine Animals. Environmental factors, biological rhythms, and behavioral adaptations in the comparative physiology of marine animals. Prerequisites: introductory biology and chemistry. C-L: Marine Sciences 250L. 4 units. *Forward*

259L. Laboratory in Biomechanics. Introduction to instruments used in investigations of solid and fluid biomechanics. Exercises and individual projects. Prerequisite: Zoology 249. 3 units. *Vogel and Wainwright*

269. Advanced Cell Biology. Structural and functional organization of cells and their components with emphasis on current research problems and prospects. Prerequisite: introductory cell biology or consent of instructor. C-L: Anatomy 269, Botany 269, Microbiology and Immunology 269, and the University Program in Cell and Molecular Biology. 3 units. *McClay and staff*

274L. Marine Invertebrate Zoology. Structures, functions, and habits of invertebrate animals under natural and experimental conditions. Field trips included. Not open to students who have taken Zoology 76L or 176L. Prerequisite: introductory biology. Offered at Beaufort. C-L: Marine Sciences 274L. 6 units. *Staff*

278L. Invertebrate Developmental Biology. Gametogenesis, fertilization, and development of invertebrates, with emphasis on experimental studies of prelarval stages. Prerequisite: consent of instructor. Offered at Beaufort. C-L: Marine Sciences 278L. 6 units. *McClay and visiting staff*

280. Principles of Genetics. Structure and properties of genes and chromosomes in individual organisms and in populations. Prerequisites: introductory biology. C-L: Botany 180, Botany 280, The University Program in Genetics, and Zoology 180. 3 units. *Antonovics (botany), Boynton (botany), and Gillham*

283. Extrachromosomal Inheritance. Genetics, biochemistry, and molecular biology of the organelles of eukaryotic cells, and cellular symbionts. Emphasis on recent literature. Prerequisite: introductory genetics. C-L: Botany 283 and The University Program in Genetics. 3 units. *Boynton (botany) and Gillham*

286. Evolutionary Mechanisms. C-L: Botany 286 and The University Program in Genetics. 3 units. *Antonovics (botany), Uyenoyama, and Wilbur*

287S. Macroevolution. Evolutionary patterns and processes at and above the species level; species concepts, speciation, diversification, extinction, ontogeny and phylogeny, rates of evolution, and alternative explanations for adaptation and evolutionary trends. Prerequisite: one course in plant or animal diversity. C-L: Botany 287S. 3 units. *Mishler (botany) and Roth*

288. Mathematical Population Genetics. Principles of formulation and analysis of dynamic mathematical models of genetic evolution. Rotating topics include: mating systems, sex ratio, stochastic processes. Prerequisite: calculus; statistics and linear algebra recommended. C-L: The University Program in Genetics. 3 units. *Uyenoyama*

293L. Population Biology. C-L: Botany 293L. 3 units. *Antonovics (botany) and Wilbur*

295S, 296S. Seminar. Topics, instructors, and course credits announced each semester. C-L: Botany 295S, 296S, and Marine Sciences. *Staff*

For Graduates

353, 354. Research. To be carried on under the direction of the appropriate staff members. Hours and credit to be arranged. C-L: Marine Sciences 353, 354. *Staff*

360, 361. Tutorials. An approved academic exercise, such as writing an essay or learning a research skill, carried out under the direction of the appropriate staff members. Hours and credit to be arranged. *Staff*

COURSES CURRENTLY UNSCHEDULED

261. Biology of Parasitism

355, 356. Seminar

RELATED PROGRAMS

The University Program in Cell and Molecular Biology. See announcement in this bulletin.

The University Program in Genetics. Genetics courses offered by the Department of Zoology are part of the University Program in Genetics; see announcement in this bulletin.

The University Program in Marine Sciences. Consult Marine Sciences in this bulletin for offerings at the Duke University Marine Laboratory.

Program in Tropical Biology. Fellowships are available for travel and subsistence in field-oriented programs in Latin America. Refer to the section Organization for Tropical Studies in this bulletin in the chapter on "Special and Cooperative Programs."

Special and Cooperative Programs

Center for the Study of Aging and Human Development

Although the center does not offer degrees, the varied programs, research laboratories, and clinical settings provide a context and resource for undergraduate and graduate students and for health professionals with special interests in adult development and aging. The center conducts multidisciplinary, two-year programs for postdoctoral fellows interested in focused training for independent research on many varied aspects of aging and adult development. Resources of this all-University program include data from two longitudinal studies, a wide range of archival data of special interest to social scientists, an animal colony, and the center's basic and applied research laboratories. A division of geriatrics coordinates research, training, and services related to the care of older adults. Undergraduate and graduate students of the University are welcome to inquire about participation in all programs at the center. Inquiries should be addressed to the Director, Duke University Center for the Study of Aging and Human Development, Box 3003, Duke University Medical Center, Durham, North Carolina 27710.

Asian-Pacific Studies Institute

The institute sponsors an agenda of visiting speakers and scholars and coordinates study abroad programs in China and Japan. A limited number of fellowships are granted which provide stipends for a two-year period. Fellows will be expected to reach the equivalent of third-year level of proficiency of language training during the term of their award. Incoming graduate students with the Ph.D. as their objective, students in good standing in the first year of study in Duke professional schools, and current Duke students enrolled in Ph.D. programs may be considered for these fellowships. Further information may be obtained from the Asian-Pacific Studies Institute, 2111 Campus Drive, Duke University, Durham, North Carolina 27706.

Canadian Studies Program

The Canadian Studies Program is supported in part by grants from the U.S. Department of Education, the Ford Foundation, and departments of Canada's provincial and national governments. Its purpose is to formalize and expand the interest of graduate students in Canada, to introduce the study of Canadian life and culture at the undergraduate level, and to encourage such study in primary and secondary schools.

The program awards a limited number of graduate fellowships and teaching assistantships for the study of Canada by American residents at Duke. Fellows must work on a Canadian dissertation topic within their disciplines. Grants of travel aid for field research in Canada are also offered.

The program sponsors lectures by Canadian specialists and supports seminars devoted to Canada. Occasionally, opportunities for study in Canada are offered to graduate students and faculty.

Inquiries should be addressed to the Director, Canadian Studies Center, 2122 Campus Drive, Duke University, Durham, North Carolina 27706.

Cooperative Program in Russian and East European Studies

The graduate schools of Duke University and the University of North Carolina offer a cooperative program leading to the A.M. and Ph.D. degrees in several disciplines (economics, history, literature, linguistics, political science, and sociology), with a concentration in Russian and East European studies. Students admitted to one institution are encouraged to enroll in courses advantageous to their programs at the other institution, and to utilize the libraries and facilities of both universities. The holdings of the two libraries in Russian and East European materials are substantial and complementary. Both libraries have a policy of purchasing all significant published works in Slavic history, economics, government, geography, literature, and linguistics. Other joint activities include periodic colloquia involving the personnel of the two institutions and distinguished visiting scholars.

A research program in Soviet economics (with special subjects such as input-output analysis and the "second economy") provides special training for graduate students in this field and publishes a series of monographs under several private foundation and government grants.

For more information, contact Professor Vladimir G. Treml, Department of Economics, Duke University, Durham, North Carolina 27706.

Center for Demographic Studies

The center promotes research and training in demographic and human ecology. Its facilities, located at 2117 Campus Drive, include a population library, the Joseph J. Spengler Collection of publications and research materials, and extensive data resources. The center does not offer degrees; it promotes the pursuit of advanced degrees, with a specialization in population studies, through either the Department of Sociology or the Department of Economics. The center's program provides opportunities for direct student participation in ongoing research projects. The program of extramural research stresses, but is not limited to, applied work in the demography of aging, health, mortality, fertility, and migration.

Inquiries for training opportunities may be directed to Dr. George C. Myers, Director, Center for Demographic Studies, Box 4732 Duke Station, Durham, North Carolina 27706.

The Program for the Study of Developed Shorelines

The Program for the Study of Developed Shorelines was established in recognition of a critical need for both academic programs and geological research on national coastal issues. The goal of the program is promotion of research, education and publications concerned with oceanic shorelines already under development. A limited number of graduate research fellowships are available to

both M.S. and Ph.D. candidates and postdoctoral support is available for individuals involved in appropriate research. The program is centered entirely within the Department of Geology and fellows supported by the program must satisfy all departmental requirements.

Islamic and Arabian Development Studies

The program in Islamic and Arabian Development Studies, established in 1977 with support from some twenty American and foreign corporations, sponsors teaching and research on Islamic themes with special reference to developmental problems of the Arabian peninsula. Emphasis is also placed on Afghanistan, Pakistan, and Syria. The program has sponsored three international conferences, has sent groups of faculty and students to Jordan and Saudi Arabia, and sponsors a Duke student delegation to the Model Assembly of the League of Arab States. The program arranged for the acquisition by the Perkins Library of the Malone Collection on Arabian Affairs and the Louis and Nancy Hatch Dupree Collection on Islamic Inner Asia. Its publication series released by Routledge and Kegan Paul of London include volumes on Islam in the Philippines and the Genesis of American Orientalism as well as volumes on Pakistan and Saudi Arabia published elsewhere. It also sponsors an outreach program which includes Appalachian State University, Belmont Abbey College, the College of Charleston, Converse College, Davidson College, Johnson C. Smith University, Old Dominion University and the University of the South. Inquiries should be addressed to Dr. Ralph Braibanti, Director, Islamic and Arabian Development Studies, 2114 Campus Drive, Duke University, Durham, North Carolina 27706.

Latin American Studies Program

The Graduate School offers an interdepartmental program in Latin American studies in conjunction with several departments: anthropology, history, economics, political science, sociology and Romance languages. In addition to fulfilling the requirements of their departments, students in the Latin American Studies Program undertake special courses of interdisciplinary study to broaden their knowledge of the Latin American field.

The holdings of Perkins Library for graduate work and research in Latin American history, inter-American relations, economic history, politics, art, and Spanish-American literature are constantly being enlarged. Program faculty are involved in different national research programs dealing with Latin American topics and offer advice on fellowship support for graduate research in Latin America and the Caribbean. Inquiries should be directed to Dr. Arturo A. Valenzuela, Chairman, Council on Latin American Studies, Center for International Studies, 2101 Campus Drive, Duke University, Durham, North Carolina 27706.

Medical Historian Training Program

The Medical Historian Training Program is conducted under the auspices of the School of Medicine and the Graduate School. The M.D.-Ph.D. program requires a minimum of six years of graduate and medical study, and the M.D.-A.M. four or five years, depending on the use of summer terms. The M.D.-Ph.D. program is intended for those students who know that their major career effort will be in teaching and other scholarly activities in the history of medicine (not necessarily to the total exclusion of clinical medicine). The M.D.-A.M., on the other hand, is appropriate for those who are undecided, but who wish to acquire a firm foundation for future study. In both programs the first two years and the last year will be spent in the medical school. All

requirements for the Ph.D. and the A.M. must be completed before the final year of the M.D. program.

Application and Admission Procedures. Applicants must meet the requirements for admission to the School of Medicine and the Graduate School in the Department of History including the MCAT and GRE exams. Those candidates holding the M.D. degree will be considered for the Ph.D. and the A.M. degrees. Candidates who have completed two years of medical school will also be considered for either degree.

Applicants should complete and submit an application to the Graduate School for admission to the Department of History.

Additional information may be obtained by writing to Dr. Seymour Mauskopf, Director of Graduate Studies, Department of History, 233 Allen Building, Duke University Durham, North Carolina 27706.

Medical Scientist Training Program

The Medical Scientist Training Program, conducted under the auspices of the Graduate School and the School of Medicine, is designed for students with a strong background in science who are motivated toward a career in the medical sciences and academic medicine. It provides an opportunity to integrate graduate education in one of the sciences basic to medicine with the clinical curriculum of the School of Medicine. The program usually requires six to seven years of study and leads to both the M.D. and Ph.D. degrees. Although the special emphasis of this program is on basic medical science, the trainees, because of their education in clinical medicine, have a remarkable range of career opportunities open to them. Graduates of this program generally follow one of two broad paths. Some directly pursue careers in teaching and research in one of the basic medical sciences, while maintaining strong ties with clinical science as a result of their combined training; others enter residency programs before pursuing investigative and teaching careers in clinical medicine, carrying with them strong academic backgrounds in the basic sciences.

Eligibility. Applicants must meet the admission requirements of both the Graduate School as a candidate for the Ph.D. degree and the School of Medicine as a candidate for the M.D. degree. Most candidates apply for admission to the first year of the program, but applications are sometimes accepted from students who are enrolled in appropriate stages of their curriculum in the Graduate School or School of Medicine of Duke University. In addition to the minimum requirements for acceptance in the Graduate School and the School of Medicine, advanced course work in science and mathematics as well as prior research experience count heavily in the selection of candidates.

Financial Support. Students admitted to the first year of the program can receive a traineeship award, consisting of a stipend and full tuition allowance, provided by a grant from the National Institutes of Health. The present annual stipend is $6,552. Current policy of the National Institutes of Health limits the duration of the traineeship to six years, but the years need not be consecutive; this permits curricula which take more than six years.

This traineeship, created by the National Research Service Award Act of 1974 (PL 93-348) provides (as do all research training awards under this act) for certain alternate service or payback requirements in the event that a research career is not pursued. Support by the NIH under the National Research Service Award Act requires the recipient to be a citizen or resident of the United States.

The Training Program. This program has been designed to offer trainees latitude in the selection of course material. Basic requirements are two academic

years composed of the first basic science year and the second clinical science year of the curriculum for medical students at Duke University. Following completion of the second year, the trainee enters the graduate program to complete the requirements for the Ph.D. degree. A final academic year of elective clinical study is necessary to complete the requirements for the M.D. degree. Both degrees are awarded at the completion of this sequence.

Additional information may be obtained by writing Professor Henry Kamin, Associate Director, Medical Scientist Training Program, Department of Biochemistry, Box 3711 Duke University Center, Durham, North Carolina 27710.

Oak Ridge Associated Universities

Duke University is one of the sponsoring universities of the Oak Ridge Associated Universities located at Oak Ridge, Tennessee. The graduate research program at Duke has available to it all the facilities of the Oak Ridge National Laboratory and the cooperative supervision of student research by the staff at Oak Ridge. Fellowships in several fields of science are available to qualified applicants.

Graduate Fellowship Program. On application by a university, ORAU awards fellowships to candidates for the master's and doctor's degrees. The student uses the fellowship to conduct thesis research in certain federal laboratories.

The application deadlines depend upon the fellowship. Further information may be obtained from Dr. Harold W. Lewis, Department of Physics, Duke University, Durham, North Carolina 27706.

Office of Research Support

The Office of Research Support, located in 012 Allen Building, provides assistance to faculty members (outside the Medical Center) who seek research funding and to graduate students who seek graduate fellowships. The office houses a library of references dealing with external funding. The ORS Fellowship File contains fellowship information for faculty, postdoctoral fellows, and graduate students from a variety of sources. It is arranged primarily by discipline and also includes such categories as "study abroad" and "dissertation support." Graduate students may take advantage of the resources of the office by browsing through the information on their own or they may make an appointment to talk with the staff by calling 684-3030. The office is open from 8:30-5:00 daily; no appointment is necessary.

Center for Resource and Environmental Policy Research

The Center for Resource and Environmental Policy Research at Duke University is committed to the study of public policies on natural resources and the environment. Housed in the School of Forestry and Environmental Studies and initially supported by the Andrew W. Mellon Foundation, the center combines the efforts of a small permanent faculty with participation by business leaders, government officials, and the faculty and students of Duke University and other universities to provide a center of excellence for the analysis of contemporary resource and environmental policy issues. The center offers a forum for the examination of public and private responsibilities for natural resources and the environment and provides a means to link the specialized knowledge of academia with the information needs of government and industry.

Graduate research assistantships are offered to qualified students researching resource and environmental policy problems. Support is available to students pursuing M.S., A.M., or Ph.D. degrees through the Graduate School at Duke

University and in conjunction with the School of Forestry and Environmental Studies or other departments. Course work is offered in both intensive and semester-long formats.

For further information, write to Center for Resource and Environmental Policy Research, 102 Biological Sciences Building, Duke University, Durham, North Carolina 27706.

Organization for Tropical Studies

Duke University is a member of an international consortium created to provide leadership in education, research, and the wise use of natural resources in the tropics. The basic OTS course, Tropical Biology: An Ecological Approach, extends for an eight-week period in January-March and in July-August. Advanced offerings are scheduled periodically in agroecology, anthropology, botany, earth sciences, forestry, geography, marine biology, meteorology, and zoology.

The application deadlines are March 1 and October 1. Fellowship applications for travel and subsistence in the field-oriented programs conducted in Costa Rica are available through the faculty representatives. Consult Dr. Donald Stone (botany), Dr. Richard White (botany), or Dr. John Lundberg (zoology) for information.
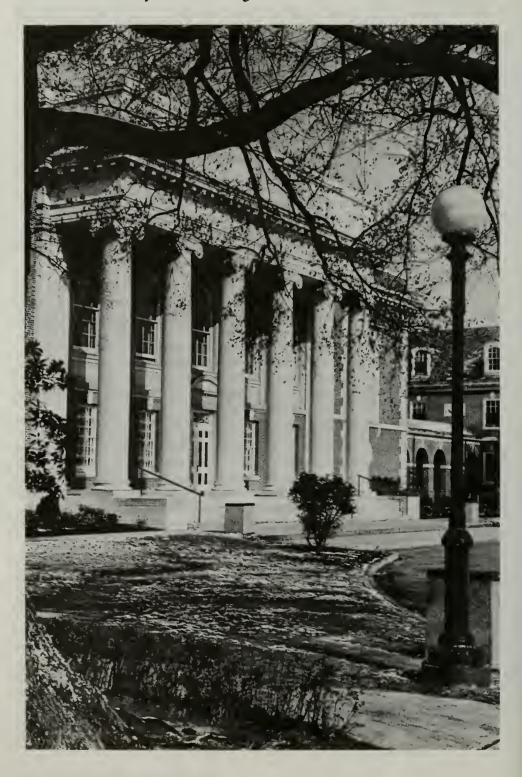
Women's Studies Research Center

The Duke-UNC Women's Research center was founded in 1982 as a collaborative endeavor between Duke University and the University of North Carolina at Chapel Hill to promote women's studies scholarship and research throughout the tri-state area of North Carolina, South Carolina, and Virginia; to support curriculum development in women's studies; and to disseminate women's studies research and information throughout the South. The center's principal focus is to explore the intersection of gender, race, and class, with a particular emphasis on the American South and Third World societies.

The center offers postdoctoral humanist-in-residence fellowships, funded by the Rockefeller Foundation, a limited number of unpaid visiting scholar affiliations, and opportunities for graduate student internships. Regular activities include an annual visiting lectureship series; a working paper series, *Southern Women: The Intersection of Race, Class and Gender*, published jointly with the research centers at Memphis State University and Spelman College; the publication of a triannual newsletter, *Branches*; and sponsorship of conferences, colloquia, and community events. The research center also houses *SIGNS: A Journal of Women in Culture and Society*.

The research center is located at 207 East Duke Building, (919) 684-6641, on the Duke campus, and at 03 Caldwell Hall 009A at UNC, (919) 966-5787.

Resources for Study

The Libraries

The libraries of the University consist of the William R. Perkins Library and its seven branches on campus (Biology-Forestry, Chemistry, Divinity, East Campus, Engineering, Music, and Physics-Math); the Undergraduate Library; the Pearse Memorial Library at the Duke Marine Laboratory in Beaufort; the Fuqua School of Business Library; the School of Law Library; and the Medical Center Library. In June 1986, these libraries contained approximately 3,550,000 volumes and ranked nineteenth in size among academic libraries in the United States. Approximately 10,000 periodicals, 14,000 serials, and 200 newspapers are received regularly. The collection includes about 7,500,000 manuscripts, 90,000 maps, 42,500 music scores, and 651,000 items in microform.

In addition to noteworthy holdings in British history, English literature, American history and literature, Commonwealth studies, Latin American history, religion, and science, the libraries include several distinguished special collections of international reputation such as the George Washington Flowers Collection of Southern Americana, the Baker Collection of Wesleyana and British Methodistica, the Mazzoni Collection of Italian Literature, the Perez de Velasco Collection of Latin American History, the Jantz Collection of German Baroque Literature and German Americana, the Trent Collection of Walt Whitman, the Trent Collection in the History of Medicine, and the Strisower Collection of International Law.

THE WILLIAM R. PERKINS LIBRARY

Collections. The William R. Perkins Library, the main library of the University, houses most of the books and journals in the humanities and social sciences, large files of United States federal and state documents, public documents of many European and Latin American countries, publications of European academies and learned societies, and special collections from South Asian, Far Eastern, and Slavic countries. The newspaper collection, with nearly 100,750 reels of microfilm and several thousand bound volumes, has long eighteenth-century files; strong holdings of nineteenth-century New England papers; antebellum and Civil War papers of North Carolina, South Carolina, Virginia, and Georgia; and many European and Latin American papers. The manuscript collection of approximately 7,500,000 items is particularly strong in all phases of the history, politics, and social and economic life of the South Atlantic region and includes significant papers in English and American literature. The collection in the Rare Book Room contains scarce and valuable materials covering a broad range of fields. The Latin and Greek manuscript collection constitutes one of the outstanding groups of its

kind in the United States. The collection of Confederate imprints is the largest in the country.

The branch libraries serve the academic disciplines bearing their names. The East Campus Library is primarily for undergraduate use; however, it also contains the principal collections for graduate and undergraduate study in art.

Materials on reference services, closed and open carrels, interlibrary loans, and microfilming/photocopying are available in the library.

THE MEDICAL CENTER LIBRARY

The Medical Center Library, located in the Seeley G. Mudd Communications Center and Library Building on the Medical Campus, provides services and informational resources necessary to further education, research, and clinical activities in the medical field. In addition to the faculties and students in the Schools of Medicine, Allied Health, and Medical Center graduate departments, the library serves the professional and technical staffs of Duke Hospital as well as other health professionals throughout North Carolina. Over 220,000 volumes are available; approximately 2,650 journal subscriptions are received currently. Professional reference librarians are available for assistance in the use of library resources, and arrangements may be made for individual or group tours, instruction, or specialized seminars.

The History of Medicine Collections, including the Josiah C. Trent Collection, consist of rare books and manuscripts and a supporting group of histories, biographies, bibliographies, pictures, and ephemeral materials. The rare books are available to all, but are restricted to library use. Most modern books may be borrowed. The History of Medicine Collections also include the Duke Authors Collection, which preserves an archival copy of each book published by a member of the Duke medical faculty.

The Frank Engel Memorial Collection consists of a small group of books for leisure reading in nonmedical subjects, supplemented by several newspapers and popular magazines.

A reserve collection of heavily used books and journals is maintained in the Medical Sciences Branch Library located in the Nanaline Duke Building and covers the fields of biochemistry, genetics, pharmacology, and physiology.

THE SCHOOL OF LAW LIBRARY

The School of Law Library, with over 370,000 volumes, serves both the University and the local legal community. It features comprehensive coverage of basic Anglo-American primary source materials, including nearly all reported decisions of federal and state courts, as well as current and retrospective collections of federal and state codes and session laws. Digests, legal encyclopedias, and other indexing devices provide access to the primary documents. A large section of the library collection is devoted to treatises on all phases of law and legal sciences, as well as history, economics, government, and other social and behavioral sciences relevant to legal research. The treatises are organized in the Library of Congress classification system and are accessible through a public catalog. Special treatise collections are maintained in several subject areas, including the George C. Christie collection in jurisprudence and the Floyd S. Riddick collection of autographed senatorial material. The library is a selective depository for United States government publications, with concentration on congressional and administrative law materials. The library receives the records and briefs from the United States Supreme Court, the Fourth Circuit Court of Appeals, and the North Carolina Supreme Court and Court of Appeals. In addition to its Anglo-American holdings, the library holds substantial research collections in foreign and international law. The foreign law collection is extensive in coverage, with concentrations in

European law and business law materials. The international law collection is strong in primary source and treatise material on both private and public international law topics. Undergraduate and graduate students whose course of study requires access to legal literature may use the library. However, access to the library may be restricted during certain times because of accreditation standards.

RECORD LIBRARY

The Department of Music has a record library separate from the university libraries with facilities for listening to records and tapes. While all materials may be used in the listening room, recordings from the departmental collection may be borrowed only by faculty of the Department of Music. Any member of the community may borrow from the Arts Council Collection of more than 2,600 records for a nominal fee.

UNIVERSITY ARCHIVES

The Duke University Archives, the official archival agency of the University, collects, preserves, and administers the records of the University having continuing administrative or historical value. The institutional archives, which also include published material, photographs, papers of student groups and faculty, and selected memorabilia, are available for research under controlled conditions in 341 Perkins Library.

Science Laboratories

Computation Center. The Duke University Computation Center (DUCC) maintains an IBM 3083 System Complex with sixteen megabytes of memory, eight IBM 3380 disk drives, eight IBM 3350 disk drives, eight IBM 3330-11 disk drives, six IBM 3420 tape drives, one Xerox 8700 laser printer, three IBM high-speed printers, a CalComp digital plotter, and an IBM 2540 card reader/punch. The DUCC facility is connected by a high-speed microwave to the Triangle Universities Computation Center (TUCC) located in the Research Triangle Park.

TUCC is a regional computer network formed and operated jointly by Duke University, North Carolina State University at Raleigh, and the University of North Carolina at Chapel Hill. The computer equipment at TUCC consists of one IBM 3081 with thirty-two million bytes of memory, one FPS-164 attached processor "super-computer," multiple 3330- and 3350-type disk drives, thirteen tape drives, card readers, and printers.

Duke's IBM 3083 is used mostly for administrative computing and as a high-speed link to TUCC. Also connected to TUCC are four medium-speed printers located in the Engineering Building, the Biological Sciences Building, the Sociology-Psychology Building, and West Duke Building on East Campus, as well as seven low-speed keyboard terminal clusters located at various points around the University. Seven clusters and two laboratories of IBM personal computers are also available. The laboratories are located in the Engineering Building and in North Building. Also available are several APPLE MacIntosh microcomputer clusters.

All users of the Computation Center facilities are urged to obtain funds to pay for computer services. Users unable to obtain grant funding may ask for financial support from their departments when applying for services. More specific information regarding Duke computing facilities may be obtained from the Director of the Computation Center.

Botanical and Zoological Laboratories. Facilities for graduate study in the Departments of Botany and Zoology are located on the West Campus. The Biologi-

cal Sciences Building contains well-equipped modern laboratories for teaching and research in the fields of botany, forestry, and zoology. Special facilities include animal rooms, greenhouses, darkrooms, refrigerated and controlled-environment laboratories, scanning and transmission electron microscopes, a Van de Graaf accelerator, X-ray machines, radiation and radioisotope equipment, and other modern research facilities. Extensive facilities for experimentation in environmental control of plant growth are available in the phytotron adjacent to the botany greenhouses.

The herbarium contains over 500,000 specimens and includes notable collections of mosses and lichens. Other assets for teaching and research are the Sarah P. Duke Gardens on the West Campus; the eleven-acre experimental plot and field laboratory developed by the Department of Botany; the Duke Forest, comprising 8,300 acres of woodland adjacent to the West Campus; the field station for the study of animal behavior and ecology; and the Duke University Marine Laboratory, an interdepartmental facility located on a small island on the coast at Beaufort, North Carolina, where twenty-two buildings and a small flotilla of ships and boats provide teaching and research facilities for resident graduate students and faculty as well as visiting individuals or groups.

Duke University, through the botany and zoology departments, is a member institution of the Organization for Tropical Studies, Inc., a consortium of universities with field station facilities in Costa Rica that provide opportunities for course work and research in tropical science.

Highlands Biological Station. Duke University holds a contributing membership in the Highlands Biological Station at Highlands, North Carolina, on the southern edge of the Blue Ridge Mountains at an elevation of 4,118 feet. The situation and the region offer an excellent opportunity for field studies and some laboratory work. A limited number of qualified students in botany and zoology may make arrangements to carry out research here. Scholarships for advanced study during the summer months are available through the station.

For further information contact Dr. M. D. Rausher, Department of Zoology, or Dr. N. L. Christensen, Department of Botany, Duke University, Durham, North Carolina 27706.

The Phytotron. The phytotron, a national environmental control facility operated for the National Science Foundation, is adjacent to the Biological Sciences Building and is administered by the botany department. The phytotron is an integrated series of plant-growth rooms, chambers, and greenhouses, with forty-six separately controlled environments providing more than 4,000 square feet of plant-growing space. The factors of the environment controlled in the units to study plant growth include light, temperature, nutrients, carbon dioxide concentration, and humidity. By using the conditions in various day and night combinations, an exceptionally large number of environments can be simulated for testing the growth responses of plants. The phytotron also includes research laboratories and facilities for studying and monitoring the physiological processes of plants.

Research space in the phytotron is available to graduate students and faculty at Duke and to members of other educational and research organizations. For information concerning the rental of research space, contact Dr. Boyd R. Strain, Director of the Phytotron, Department of Botany, Duke University, Durham, North Carolina 27706.

Duke Forest. The Duke Forest comprises approximately 8,300 acres of land in five major divisions and several smaller tracts. A ten-minute walk from campus will take one well into many parts of the Durham Division, and a network of roads and fire trails make almost all areas of the forest easily accessible.

The forest lies primarily in Durham and Orange counties, near the eastern edge of the piedmont plateau, and supports a cross-section of the woodlands found in the upper coastal plain and lower piedmont of the Southeast. A variety of timber types, plant species, soils, topography, and past land use conditions are represented. Elevations range from 260 to 760 feet. Soils of the region are derived from such diverse parent materials as metamorphic rock of the Carolina slate formation, granite, Triassic sedimentary rock, and basic intrusives.

The forest serves for research in such areas as forestry, zoology, botany, and ecology by faculty and students at Duke and neighboring universities. Background information useful to researchers covers such features as soils, topography, inventory, plantation and cultural records, as well as a bibliography of past and current studies. Current work on problems associated with developmental pressures at the urban-rural interface and integrated approaches to natural resource management have multiplied the value and benefit of the forest. For information contact: Judson Edeburn, Duke Forest Resource Manager, Room 206-A Biological Sciences Building, Duke University, Durham, North Carolina 27706.

Forestry Sciences Laboratory. The Forestry Sciences Laboratory of the USDA Forest Service, Southeastern Forest Experiment Station is located in the Research Triangle Park near Durham. This research organization provides excellent opportunities to complement research conducted by students in the School of Forestry and Environmental Studies. Specialized research projects in timber investment opportunities, market efficiency, forest soils, insect toxicology, and the economics of forestry in developing countries are currently under way at the laboratory. The staff of the laboratory is available for consultation and participation in seminars. Arrangements may be made for students to conduct certain aspects of their research at the laboratory.

Marine Laboratory. The Duke University Marine Laboratory (DUML), an interdepartmental training and research facility of the University, is located on Pivers Island, adjacent to the historic seacoast town of Beaufort, North Carolina. Because of the richness and diversity of the area's flora and fauna (including direct access from the laboratory to the open ocean, Cape Lookout National Seashore Park and the Outer Banks, estuaries, sand beaches, wetlands, and coastal forests), the laboratory provides an excellent opportunity for marine biological study and research. The laboratory accommodates nearly 1,500 visitors per year, including fifteen to twenty resident graduate students who are involved in year-round activities. (For additional information concerning the graduate program, refer to the *Bulletin of Duke University: Marine Laboratory* or the section on marine sciences in the chapter "Courses of Instruction.") The physical plant consists of twenty-three buildings, including classroom laboratories, six research buildings, four dormitories, a maintenance complex, and a dining hall. The laboratory has skiffs, a 50-foot training vessel, the R/V *First Mate*, and a new 135-foot research and training vessel, the *Cape Hatteras*, which is operated by the Duke/UNC Oceanographic Consortium.

For information concerning teaching and research space, write to the Personnel and Auxiliaries Office, Duke University Marine Laboratory, Beaufort, North Carolina 28516.

Zoology Field Station. The Zoology Field Station, located less than one mile from campus, provides facilities for the study of penned, free-ranging, and caged animals in a protected wooded area of eighty acres. These facilities include soundproofed observation chambers, barns, aviaries, pens for large animals and birds, and two ponds. For information regarding research space, write to Dr. Mark D. Rausher, Department of Zoology, Duke University, Durham, North Carolina 27706.

Primate Center. The Duke University Primate Center is located in the Duke Forest about two miles from the main campus. The colony is composed of approximately 755 prosimian primates representing five families, eleven genera, nineteen species, and twenty-six varieties. This is both the largest and the most diversified colony of living lower primates in the world. The center also houses frozen, preserved, and fossil primate collections. These collections and animals are utilized by faculty members and both graduate and undergraduate students in the Departments of Anatomy, Anthropology, Forestry, Geology, Psychology, and Zoology for all qualified researchers in primate paleontology, prosimian aging, locomotion, cytogenetics, comparative anatomy, behavior, and physiology. Applications for graduate study in one of these areas should be directed to the Director of Graduate Studies of any of the six departments. For information pertaining to the use of the Primate Center, graduate studies, or availability of research space, write to Dr. Elwyn L. Simons, Director, Duke University Primate Center, 3705 Erwin Road, Durham, North Carolina 27705.

The Vivarium. The vivarium facilities are maintained solely to support research and teaching programs of Duke University. The central vivarium contains forty-four animal housing rooms, four sterile operating rooms, two necropsy rooms, ten project rooms, and a diet kitchen. Presently, Duke medical students and physician's associate students attend classes in animal surgery at the vivarium. A farm facility also is available to accommodate dog kennels and large farm animals. The vivarium is staffed by veterinarians, technicians, and caretakers to assure humane care and treatment of animals. The vivarium is fully accredited by the American Association of Laboratory Animal Care which assures compliance with standards of NIH.

Psychology Laboratories. The facilities of the Department of Psychology include sound-attenuating and electrically shielded rooms, some for use with human subjects and others for use with animal subjects; rooms for computer-controlled experiments in human perception, memory, and language; electrophysiological recording rooms; and interconnected rooms to provide observation, communication, and videotaping capabilities for the study of social interactions and for the study of personality and clinical processes.
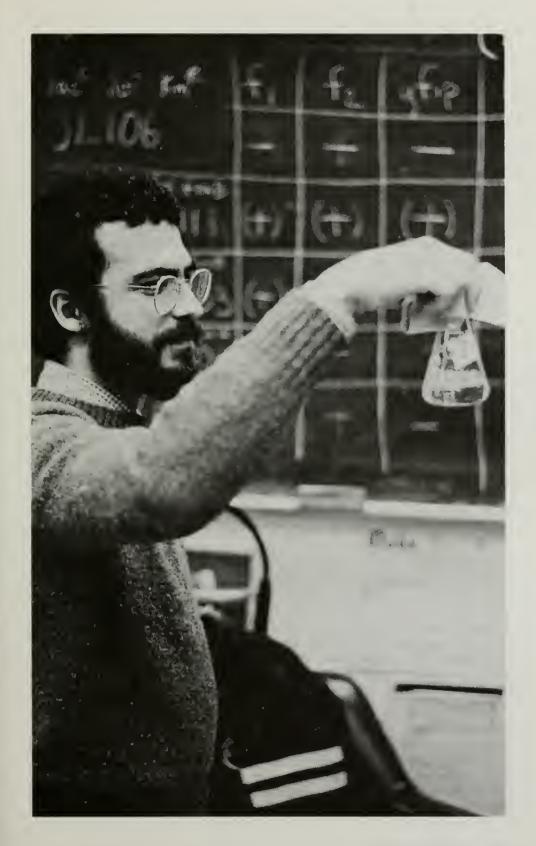
As well as such specially designed spaces, there is a variety of support facilities. To aid in the study of animal behavior and psychobiology, there are a breeding colony of ring doves; colonies of pigeons, rats, and mice. To aid in physiological research, there are surgeries, histology laboratories, and photographic darkrooms. To aid in data collection and analyses, for both human and animal experiments, there are facilities for microprocessor-controlled experiments and videotaping in a variety of situations, including special setups for the study of operant conditioning, perception, and behavioral ecology.

Several laboratories have independent computers, some with graphics capabilities, and there are direct connections to the large-scale computers at the Triangle Universities Computation Center. There are also fully equipped machine, woodworking, and electronics shops staffed by full-time technicians. Additional facilities for research and teaching are available in the laboratories and clinics of the adjacent Duke Medical Center, in the Veterans Administration Medical Center nearby, and in the universities and research companies in the area.

A number of clinical installations for adults and children, specializing in clinical and guidance problems, cooperate with the department in providing facilities for research and training. Clinical research is often conducted at the Duke Psychology Clinic operated by the clinical psychology program. This facility offers a full range of clinical services to adults, children, and families.

Chemistry Laboratories. The Department of Chemistry is housed in the Paul M. Gross Chemical Laboratory. This well-equipped modern chemical laboratory

provides conditions very conducive to research. In-house nuclear magnetic resonance facilities include Varian XL-300, IBM NR-80, JEUL 60 and 90 multinuclear FT-NMR spectrometers, and several routine proton instruments. The University NMR center, of which chemistry is a part, also includes GE GN-500 and GN-300 (wide bore) spectrometers. A Bruker 250 MHz multinuclear high field FT-NMR system shared with the Research Triangle Institute is located in nearby Research Triangle Park. Two ESR spectrometers, including a Varian E-9, provide excellent facilities for research in electron spin resonance. Mass spectrometric service is provided by a CEC 21-491 mass spectrometer and two Hewlett-Packard GC-MS systems, as well as access to an A.E.I., Ltd., MS-902 located in the Research Triangle Park. X-ray diffraction cameras of all types are available, along with Enraf-Nonius automatic and Picker automatic full-circle diffractometers. Numerous instruments of varying sophistication for photoacoustic, fluorescence, infrared, U.V., and ORD-CD spectroscopy are available. Several preparative and analytical gas and liquid chromatographs are also located in the building. Computing facilities in the Department of Chemistry include a cluster of twelve IBM personal computers and a cluster of five remote job entry terminals which utilize an IBM Series 1, WIDJET system to access the dual IBM 370/165-Amdahl systems of the Triangle Universities Computation Center via a 19 Kb microwave link. The department also houses a DEC 11/42 system (1 Mbyte, 16 terminal) which operates in a multiuser FORTRAN environment emphasizing computer graphics as a training tool. An AED 512 color graphics/imaging terminal is also available. Numerous other computers are associated with specific research groups. The department has a machine shop and an electronics shop. The facilities of the Duke University Marine Laboratory on the coast at Beaufort, North Carolina, are available for specimen and water collecting; joint research projects with members of the resident staff have been conducted in the areas of biological chemistry and chemical aspects of oceanography. The Department of Chemistry Library, with holdings of approximately 42,000 volumes, is also located in the Paul M. Gross Chemical Laboratory. The library receives 600 current scientific serial publications and has a terminal facility for complete information retrieval.

Physics Laboratories. The Physics Building is devoted to research and instruction in the Departments of Physics and Mathematics. Additional space is provided in the adjacent Nuclear Physics Building. Graduate students usually have office space in one of these two buildings.

Nearly half the Physics Building is devoted to special laboratories for research in molecular and atomic, nuclear, high-energy, low temperature, and solid-state physics, and in astrophysics and quantum electronics. Special equipment includes microwave facilities operating to beyond 1000 GHz; picosecond, dye, carbon dioxide, and far infrared lasers; one 4 MeV and one high-resolution 3 MeV Van de Graaf accelerator; a 30 MeV cyclotron/tandem Van de Graaf accelerator; a helium liquefier, cryostats, magnets, and associated equipment for research down to the millidegree Kelvin temperature range; a VAX 11/780 computer and several Vector microcomputers for data processing in the high-energy physics laboratory; VAX 11/780 and VAX 750 computers for collecting and processing data in the nuclear structure laboratory; and a Harris H-800 computer for general purpose use.

The Physics-Mathematics Library contains a large selection of books and periodicals. A spacious, well-equipped instrument shop, electronic shops, and a glass shop located in the Physics Building are staffed by eight instrument makers, eight electronics technicians, and a glassblower.

Engineering Research Laboratories. The laboratories of the four departments of the School of Engineering contain extensive basic equipment that may be applied in several specialized fields. The facilities available for instruction and

research are suggested by the following brief listing of equipment found in each department:

Biomedical Engineering. Ultrasound imaging and transducer laboratories; cellular electrophysiology and neurophysiology instrumentation; stereomicroscope, micromanipulators, stimulators, isolation units, and microelectrode puller; facilities for studying biomedical materials and surface interactions; polarizing microscope, internal reflectance infrared spectrophotometer, and dialyzers; soft tissue creep and relaxation test system; biocellular material testing equipment; quantitative videomicroscopy, laser fluorescence microscopy, and nanogram-level micromechanical testing equipment; microprocessor development systems; microprocessor data acquisition and control systems; cardiorespiratory measurements; respirator; and a VAX 11/780 and several PDP-11 and IBM digital computers.

Civil and Environmental Engineering. Well-equipped research laboratories are available for work in environmental engineering, soil mechanics and geotechnical engineering, solid mechanics and materials engineering, structural mechanics and structural engineering, fluid mechanics, water resources and ocean engineering, and urban systems and transportation engineering. Available research facilities include three independent closed-loop electrohydraulic dynamic loading systems (MTS) capable of applying pulses of any shape and controlled in force or displacement modes, frequency range up to 100 cps., load capacity 6,000 and 50,000 lbs. (the 6,000 lbs. actuator can develop a constant crosshead speed up to 50,000 in./min.); equipment for fabricating specimens of and testing fiber-reinforced polymer composites; environmental chamber for testing in the temperature range of -320° to 500° F.; ultra-high-pressure triaxial shear apparatus for confining pressures up to 100,000 psi; particle tracking X-ray equipment for soil deformation studies; rock-testing facilities; model-testing equipment for anchored walls, penetrometer studies, and deep pile foundations; a large-aperture research polariscope; a reflective photoelastic polariscope; sustained-loading facility for long duration in studies of prestressed concrete; wet and dry environmental laboratories equipped to analyze a range of physical, chemical, and biological processes; a fully integrated resource recovery pilot plant; calorimetry for the measurement of heating values of secondary fuels; air classifiers interfaced with computer readout; several microcomputers, including the CDC 110, Apple II, and IBM 5150 personal computers with graphics capability; and access to the extensive computer facilities of the Duke University Computation Center as well as the Triangle Universities Computation Center.

The research facilities in water resources are located both indoors and outdoors. Indoors, the laboratory houses flow-measurement devices (flumes, Venturi meters, manometers, etc.) and digital computation hardware. A dual capability teletype terminal is hard-wired to a Data General 32-bit MV/8000 computer supported by three-dimensional color graphic printers and, through an acoustic coupler, the same terminal can be switched to access an IBM 3081 computer at the Triangle Universities Computation Center, the WATSTORE data base system of the U.S. Geological Survey in Reston, Virginia, or any other computation system connected via telephone lines. Outdoors, the Sarah P. Duke Gardens watershed (about 100 acres on campus) has been instrumented with rain gauges, compound weirs, and liquid-level flow recorders enabling hydrologic simulation and calibration and verification with real data.

Electrical Engineering. Digital data processing laboratory equipped with the Data General 32-bit MV/8000 as a time-sharing computer for interactive design, graphics, computation, and computer-aided engineering; Digital Equipment VAX 11/750 work station for VLSI design; microwave facilities for experimentation up to 35 GHz; robotics with a GEP-50 robot; solid-state laboratory with X-ray diffraction and EPR spectrometer; microprocessor laboratory; solid-state power conditioning

laboratories with dedicated computers for controlling instruments, including digital processing oscilloscopes and network and impedance analyzers, and for computer-aided design; semiconductor nMOS fabrication laboratory for integrated circuits; and access to the design, fabrication, and research facilities of the Microelectronics Center of North Carolina.

Mechanical Engineering and Materials Science. Biotechnology Laboratory: The biotechnology laboratory investigates how temperature, various organic and inorganic chemicals, and light affect the rates and yields of plant and microbial processes. Both mathematical modeling and experimental studies are carried out. Research equipment includes Millipore filter-sterilization apparatus for media preparation, autoclaves, Wild M5A stereomicroscope, Olympus BHS compound microscope with fluorescence and photomicrography systems, photometer, irradiometer, UV-sterilization hood, digital pH/DO meter, colorimeter, shaker water bath, heating and cooling circulators, crossed-gradient culture apparatus, IBM XT personal computer system with graphics. Controlled-environment plant-growth chambers are available on a rental basis in the phytotron.

Integrated Computer-Aided Engineering Laboratory: The ICAE computer lab is currently built around a Data General MV/8000 super-minicomputer jointly shared by the mechanical engineering and electrical engineering departments. The number of terminals and other peripherals available in mechanical engineering currently consists of four Tektronics graphics terminals with hardcopy, a Hewlett-Packard 9836 color graphics system with two digitizing tablets, five General Electric printing terminals, various other alphanumeric terminals, and a medium-speed line printer. In addition, there are a number of Hewlett-Packard 85 desktop computers and associated peripherals which can be linked to the main system. Additions are rapidly being made to the available hardware and it is expected that this will continue in the future. There are a number of sophisticated software packages, implemented by mechanical engineering faculty and students, available on the MV/8000 system. Aside from the engineering data management system RTI/RIM, which is the backbone of the department's integrated design approach, the TKLIB graphics package and the general purpose finite element package SPAR are being used and refined. Many special purpose programs have also been developed for the system and these address such areas as gear design, two-dimensional general field problems, and space frame analysis.

Dynamic Systems and Control Laboratory: The dynamic systems and control laboratory has a variety of basic instruments for measurement and control, for example, storage and dual-beam cathode ray oscilloscopes; X-Y and strip chart recorders; acceleration, temperature, pressure, strain, and force transducers; electrodynamic shaker; and spectrum analyzer. A miniac analog computer available in the laboratory with built-in nonlinear function generator and digital logic capabilities can be used for linear and nonlinear system simulation and controller synthesis.

Fluid Mechanics Laboratory: The fluid mechanics laboratory offers a variety of instrumentation for experimental research in turbulence and electrohydrodynamics, including laser-Doppler and hot-wire anemometry. The laboratory includes a subsonic wind tunnel with 6 component balance and very large aspect ratio electrostatic precipitator.

Heat Transfer Laboratory: The undergraduate laboratory provides equipment and instrumentation for temperature calibration and measurement, free and forced convection experiments, radiation pyrometry and spectral analysis, heat exchanger performance studies, and optical measurements of heat and mass transfer by a Mach-Zender interferometer. Research instrumentation and equipment include a 100-channel digital data acquisition system, temperature and pressure transducers,

boiling heat transfer loop, various flow and energy measurement devices, and a number of compressor-condenser and pump systems.

Materials Science Research Laboratory: Materials science research is supported by a full complement of facilities for modifying and testing the properties of materials and for examining the effects of changes in their internal structure. Heat-treatment and mechanical testing facilities include a variety of vacuum and controlled atmosphere furnaces for melting alloys, doping semiconductors, and growing crystals, metallurgical furnaces for heat-treating alloys, and a completely instrumented 10,000-pound capacity Instron mechanical testing machine. For materials analysis there is a large range of metallographic facilities, including hardness testers and optical, as well as scanning and transmission electron, microscopes. The scanning electron microscope is equipped for energy dispersive chemical analysis and includes a dedicated data processing unit for both storage and analysis of energy-dispersive X-ray results. Other specialized equipment includes both Doppler-broadening and lifetime equipment for positron annihilation studies of defects in solids. The output of these units is hard-wired to a Data General MV/8000 computer, the capacity of which permits a full range of data analysis methods. Other specialized equipment includes access to X-ray diffraction units including a Berg-Barrett X-ray typograph camera, Debye-Scherrer camera with Gondolphi attachment, a back reflection Laue camera, and a liquid helium low temperature X-ray cryostat. Complete darkroom and other facilities for photographic work are also available. Thin film deposition apparatus permits the preparation of a large variety of both metallic and semiconducting thin films by either normal vacuum deposition or by glow discharge decomposition methods. A variety of thin film test facilities, including high-sensitivity photoconductivity, thermoelastic testing, and other electrical and physical thin film testing apparatus is also available. A differential thermal analysis facility allows the determination of basic phase diagram information as well as quantitative calorimetric data for metallic, polymeric, and ceramic materials.

The shop facilities of the School of Engineering, as well as those located elsewhere on campus, are available to graduate students in all four departments.

The School of Engineering houses a Data 100 medium-speed card reader and printer which communicates directly with various computers located at the Triangle Universities Computation Center in the nearby Research Triangle Park.

F. G. Hall Laboratory for Environmental Research. The F. G. Hall Laboratory for Environmental Research contains eight hyperbaric and/or hypobaric pressure chambers used to simulate altitude or deep-sea diving conditions, for the purpose of both experimentation and medical treatments. The interconnected steel chambers can simulate depths of 3,600 feet, or altitude of 155,000 feet, a capability unmatched in the United States. In 1982 a research dive to 2,250 feet set a new world's record. Research of this type has led to the development of safer and faster decompression tables, better breathing mixtures, and improved types of diving equipment together with new treatments for diving accidents and diseases treated with high-pressure oxygen. The laboratory provides opportunities for basic and applied research and for training physicians, postdoctorates, and graduate students in pressure-related medicine and physiology. The program is multidisciplinary with major participation by the Departments of Anesthesiology, Physiology, Medicine, Surgery, and the School of Engineering. Administration is by the Vice President for Research, Dr. C. Putman.

The Medical Center. The Medical Center currently occupies approximately 140 acres. The southern portion is contiguous with the main quadrangle of the University and consists of the following: Davison Building, Duke Hospital South, Baker House, Barnes Woodhall Building, Diagnostic and Treatment Building,

Ewald W. Busse Building, Eugene A. Stead Building, Clinical Research II, and the Edwin A. Morris Clinical Cancer Research Building.

The northern portion includes the Nanaline H. Duke Medical Sciences Building, Alex H. Sands Medical Sciences Building, Edwin L. Jones Basic Cancer Research Building, Clinical Laboratory and Medical Research Building, Bell Building, Seeley G. Mudd Communications Center and Library, Searle Center for Continuing Education, Eye Center, and Duke Hospital North. An addition to Duke Hospital North to house two more Nuclear Magnetic Resonator (NMR) machines is under construction.

In the western section of the campus are: Research Park Buildings I, II, III, and IV; the Vivarium; and the Animal Laboratory Isolation Facility. A new environmental safety building and a surgical oncology research building are under construction.

In the eastern section of the campus are Pickens Rehabilitation Center, Civitan Mental Retardation and Child Development Center, Child Guidance Center, and Trent Drive Hall.

On the sign in the image: Edwin L. Jones
Cancer Research Building

Living Accommodations

Duke University has several residential facilities in which single graduate and professional students live, however, married student housing is not available. Married students should refer to the section entitled Off-campus Housing.

Town House Apartments. Town House Apartments, located about three blocks from the main East-West Campus bus line, is a thirty-two-unit complex which houses single graduate and professional school students. These apartments are more spacious than most apartments found on campus or in Durham. Because of its location away from the academic facilities, students find that it offers a change from normal campus life and activities. They are available for continuous occupancy throughout the calendar year.

Each air-conditioned apartment includes a living room, a master bedroom, a smaller bedroom, a bath and a half, and an all-electric kitchen with a dining area. Spacious closets and storage spaces are provided within each apartment. A swimming pool, located in the center of the complex, is open during the late spring and throughout the summer months.

Occupants must make arrangements with the local utility companies to pay for electricity, gas, and telephone service. These companies usually require a deposit when initial applications for service are made. Utility companies should be contacted prior to arrival as it usually takes several days to obtain service.

Central Campus Apartments. During 1975, Duke University completed a 500-unit apartment complex. Apartments are available throughout the calendar year for continuous occupancy to single students attending graduate and professional schools.

All Central Campus Apartments are completely furnished by the University. An itemization of furnishings is included with the floor plans sent out in the application packet.

A swimming pool, located in the center of the complex, is open during the late spring and throughout the summer months. Additional facilities include a pub, convenience store, tennis courts, and basketball courts.

All utilities—water, heat, air-conditioning, and electricity—are provided. Telephones, which are provided in preinstalled locations in each apartment, are serviced through Duke University's Tel-Com telephone service. Central Campus Apartments residents are responsible for having their phones connected.

Efficiency, two-bedroom, and three-bedroom apartments are rented to single students. Efficiency units are very limited in number and are generally not avail-

able to new students. Spaces in apartments for single students are provided on an individual basis with each student paying rent per academic term to the University. This method permits students to share apartments with others of their choice. When this is impractical, the Department of Housing Management strives to place persons with similar interests together.

Modular Homes. The University owns six prefabricated modular homes which are located one block from the main East-West Campus bus line. Three of the three-bedroom homes are occupied by single graduate and professional students. The houses, completely furnished, provide more privacy than most apartments and are available to single graduate and professional students for continuous occupancy throughout the calendar year.

In addition to having three bedrooms, each home contains a full bath, an all-electric kitchen, a dining area, and a living room. Sliding glass doors in the living room open onto a wooden deck. An outside storage area is provided in addition to spacious closets within the home. Except for the bathroom, kitchen, and dining area, the homes are completely carpeted and paneled.

Residents of the modular homes are responsible for making arrangements with local utility companies for electricity and telephone services.

Application Procedures. When students are informed of their acceptance to Graduate School they will also receive a postcard on which to indicate preference for University housing. This postcard should be returned to the Department of Housing Management. Detailed information on the types of accommodations and application forms will be forwarded to the accepted student. Assignment to all University housing is made on a first-apply, first-assigned basis, and it is not guaranteed.

Off-campus Housing. The Department of Housing Management maintains a listing of rental apartments, rooms, and houses provided by property owners or real estate agencies in Durham. These listings are available in the department only; during the summer an assistant is available to answer questions and aid students in their attempt to obtain housing off campus. Information on commercial complexes in the Durham area may be obtained by indicating a preference for off-campus housing on the postcard which you will receive with your acceptance notice. Except for assuring that owners sign a statement of nondiscrimination, off-campus property is in no way verified and neither the University nor its agents negotiate between owners and interested parties.

The search for accommodations should begin as soon as possible after acceptance to the Graduate School. A visit of two or three days will allow you the opportunity to make use of the off-campus service and to inspect personally the available facilities.

Duke University Marine Laboratory. The Duke University Marine Laboratory, located on Pivers Island, has cottage-type residence halls which are available. Further information may be obtained from the *Bulletin of Duke University: Marine Laboratory.*

Food Services

Graduate students who wish to eat on campus may participate in Duke University Food Services' innovative food program. The meal plan allows users to select the location, the time, and the type of food service they desire. At the desired operation, select from the offerings at that location and present your Duke card for payment.

East Court Cafeteria is located in the East Campus Union Building, and the *Blue & White Cafeteria* is located in the West Campus Union Building. These

cafeterias afford customers the opportunity of paying a predetermined price and eating as much as they like. Each cafeteria offers a selection of two or three entrees, a choice of vegetables, a salad bar, a dessert bar, and self-service ice cream and yogurt bars.

Trent Cafeteria, in the mall on the lower level of Trent Drive Hall, offers a wide a la carte selection.

The *University Room*, located in the West Campus Union Building on the main level, is open Monday through Friday and serves breakfast, lunch, and a fine selection of steaks, chops, and seafood for dinner.

The *Rathskellar*, in the Bryan Center, offers gourmet burgers, pasta, broiled chicken, Mexican style foods, and salads.

The *Downunder*, located in the lower level of the Gilbert-Addoms Residence Hall, is open evenings and has a wide variety of fast foods.

The *East Campus Dope Shop* is a soda fountain, and the *Pub at Central* serves sandwiches and drinks.

Gradeli's, located in the mall area of Trent Drive Hall, has a fine selection of hot and cold sandwiches, as well as a small convenience store. The *Cambridge Inn* has big burgers, deli sandwiches, a full selection of convenience food items, and several brands of draft beer. The *Boyd-Pishko Cafe* is fast food right in the middle of the Bryan Center. It offers breakfast biscuits, danish, donuts, and beverages. At lunch it offers burgers, hot dogs, chicken filet sandwiches, ice cream, salads, and beverages.

The *Sprout*, located at Trent Drive, and the *Leaf & Ladle*, in the West Campus Union Building, are salad bars with fresh vegetables, breads, fruits, and home-made soups.

The *Magnolia Room*, in the East Campus building, is open each evening, Tuesday through Friday. Seating is by reservation only. The *Oak Room*, on the second level of the West Campus Union Building, is a full-service restaurant with a wide variety of luncheon and dinner offerings.

Two other services are *Pizza Devil* for pizzas picked up or delivered, and *University Catering* for delivery of anything from coffee-break fare to a full meal. Catering arrangements can be made for groups or special occasions.

For more information on the meal plan and to open an account, visit the Auxiliaries Contract Card Office. It is located on the lower level of the West Campus Union Building, Room 024.

Services Available

Medical Care. The purpose of the Student Health Service is to provide any medical care and health advice necessary for a sense of well-being as the student participates in the University community. The health service maintains the Student Health Services Clinic located in the Pickens Building on West Campus and the University Infirmary on the East Campus. (The University Infirmary is not open during the summer.) Emergency transportation can be obtained by the Duke campus police. A separate fee for the Student Health Service is assessed. The Student Health Service offers varied benefits.

The Student Health Services Clinic offers the student outpatient services, routine laboratory and X-ray examinations in the clinic for the treatment of acute illness or injury, and advice and assistance in arranging consultation for medical treatments. Fees for such consultations or treatments must be paid by a student who is not covered by an insurance plan.

The facilities of the University Infirmary are available to all currently enrolled full-time students in residence during the fall and spring. Hospitalization in the University Infirmary is provided for treatment of acute illness or injury as author-

ized by the Student Health Services Clinic physician. Students are required to pay for their meals while confined to the infirmary.

The resources of the Duke University Medical Center are available to all Duke students and their spouses and children, although any bills incurred at Duke Hospital or any other hospital are the responsibility of the student, if not covered by an insurance plan. The Student Health Program does not provide health care for spouses and dependent children of married students. Coverage of the married student's family is provided in the University's Student Accident and Sickness Insurance Plan for an additional fee.

The University has made arrangements for a Student Accident and Sickness Insurance Plan to cover all full-time students for a twelve-month period. For additional fees a student may obtain coverage for a spouse and a child. Although participation in this program is voluntary, the University requires all graduate students to be financially responsible for medical expenses above those covered by the University Student Health Program through the University Accident and Sickness Policy, a private policy, or personal financial resources. Students who have equivalent medical insurance or wish to accept the financial responsibility for any medical expense may elect not to take the Duke plan by signing a statement to this effect. *Each full-time student in residence during the fall and spring must purchase this student health insurance or indicate the alternative arrangement.* The Student Accident and Sickness Insurance Policy provides protection twenty-four hours per day during the full twelve-month term of the policy for each student insured. Students are covered on and off campus, at home, while traveling between home and school, and during interim vacation periods. The term of the policy is from the opening day of school in the fall. Coverage and services are subject to change each year as deemed necessary by the University in terms of costs and usage.

All full-time students are enrolled in and charged for the Student Accident and Sickness Insurance Policy unless they submit properly completed and signed waivers by the published due date. All foreign students are required to enroll in the University insurance plan or complete the waiver listing the policy number and name of the insurance company providing their comparable coverage. Full payment for student insurance is due at the beginning of the term (insurance may not be paid via payroll deduction).

Counseling and Psychological Services. Counseling and Psychological Services (CAPS) is a component of student services which provides a coordinated, comprehensive range of counseling and developmental services to assist and promote the personal growth of Duke students.

The professional staff is composed of psychologists, clinical social workers, and psychiatrists experienced in working with young adults. They provide direct services to students including evaluation and brief counseling/psychotherapy regarding a wide range of concerns. These include issues of self-esteem and identity, family relationships, academic performance, dating, intimacy, and sexual concerns. While students' visits with counselors are usually by appointment, a walk-in consultation service is provided two hours each weekday for students with urgent personal concerns.

Each year CAPS offers a series of self-development seminars focusing on skills development and special interests. These explore such interests as stress management, assertiveness training, career planning, public speaking anxiety management, and issues pertaining to graduate and professional women. Interested students may contact CAPS for further information.

As Duke's center for administration of national testing programs, CAPS also offers a wide variety of graduate/professional school admissions tests and professional licensure and certification examinations.

Another function of CAPS is the availability of the staff to the entire University community for consultation and educational activities regarding student development and mental health issues affecting not only individual students but the campus community as a whole. The staff works with campus personnel including administrators, faculty, student health staff, religious life staff, and student groups in meeting needs identified through such liaisons. Staff members are available to lead workshops and discussion groups on topics of interest to students.

CAPS maintains a policy of *strict confidentiality* concerning information about each student's contact with the CAPS staff. If students desire that such information be released to anyone, they must give written authorization for such release.

Initial evaluation and brief counseling/therapy, as well as career and skills development seminars, are covered by the student health fee. There are no additional costs for these services. If appropriate, referral may be made to other staff members or to a wide variety of local resources.

Appointments may be made by calling 684-5100 or coming by the office in 214 Old Chemistry Building, West Campus between 8:00 A.M. and 5:00 P.M. Monday through Friday. If a student's concern needs immediate attention, that should be made known to the secretary and every effort will be made to arrange for the student to talk with a staff member at the earliest possible time.

Office of Placement Services. Duke University maintains an Office of Placement Services which acts as a liaison between the University and potential employers in business and industry, education, and government. The office is located in 214 Flowers Building.

The staff is available to talk with graduate students about their future professional plans. Students who are eligible to register with the office are offered an opportunity to assemble a complete dossier of academic records and recommendations to support applications for permanent positions and to have a permanent file for future reference. Pertinent recommendations should be accumulated while the student is enrolled at Duke. Interviews with representatives visiting Duke are scheduled throughout the year for students registered with the Office of Placement Services. Part-time employment listings for the campus and Durham area are maintained in the office. All students interested in working during the summer session should register at the beginning of the term.

All services are offered without charge to Duke students and alumni.

Student Affairs

Cocurricular Activities. Graduate students at Duke University are welcome to use such University recreational facilities as swimming pools, tennis courts, the golf course, and to affiliate with the choral, dance, drama, music, and religious groups. They may become junior members of the American Association of University Professors and may affiliate with Phi Beta Kappa and social fraternities.

A full program of cultural, recreational, and religious activities is presented by the Office of Cultural Affairs, the Duke University Campus Ministry, the Duke University Union, the Office of Student Activities, and recreational clubs. The Duke University Union sponsors a wide range of programs through its committees, which are open to all segments of the campus community. Included are touring Broadway shows; rock, jazz, and pop concerts; speakers; films; a film-making program; the largest fully student-run television station in the country; art exhibits in two galleries; and a broad program in crafts located in Southgate Dormitory and the Bryan University Center. The Aquatic Center and the Card Gymnasium pool are available to students, faculty, and staff families. The handball, racquetball, squash, and tennis facilities and the weight room in the basement of the Aquatic Center are also available. Interested

students may participate in softball and other team sports.

The University Center complex includes the new Bryan University Center, which houses the Information Center, two drama theaters, a film theater, lounges, stores, meeting rooms, games room, the Terrace Cafe, art gallery, and other facilities; the West Union, which includes dining facilities; and Flowers Building, which includes student publications, Page Auditorium, and the University box office.

Inquiries should be directed to the Recreation Office, 105 Card Gymnasium; the Office of Cultural Affairs, 109 Page Building; Duke Chapel; the Duke University Union, Bryan University Center; or the Office of Student Activities, Bryan University Center.

Full information regarding the scheduling of major events and programs for the entire year will be found in the Duke University *Annual Calendar;* detailed and updated information for the fall and spring semesters in the *Weekly Calendar,* available each Friday; updated information for the summer session in the *Summer Session Calendar,* published at the beginning of each summer term; and the Duke *Chronicle,* published each Monday through Friday during the fall and spring and each Wednesday during the summer. Copies of the Duke University calendars may be obtained at the information desk, Bryan University Center, or the calendar office, Page Building. Also during the summer, the *Summer Session Newsletter* is published weekly by the summer session office and is available at convenient locations.

Graduate and Professional Student Council. The Graduate and Professional Student Council is the representative body for the students of graduate departments and professional schools. The council provides a means of communication between schools and between graduate students and the administration. The council selects graduate students for membership on University committees. Representatives of each department and officers of the council are selected annually.

Religious Life. The Duke University Chapel, open from 8:00 A.M. until 11:00 P.M., provides a magnificent setting for daily prayer and meditation. In addition, a variety of worship experiences are provided throughout the week including the University service of worship at 10:55 A.M. each Sunday and morning prayer at 8:35 A.M. each weekday. The 150-voice Chapel choir is open by audition to all interested singers.

The Duke Campus Ministry provides a larger ecumenical community for numerous religious groups on campus as well as pastoral care for any member of the University community. Graduate student participation is welcome and strongly encouraged. Contact the office of Minister to the University, Duke Chapel, for further details.

Visiting Scholars

The libraries and other facilities of Duke University are made available, to the extent practicable, to faculty members of other colleges and universities who wish to pursue their scholarly interests on the Duke campus. Such visitors are not charged unless they wish to participate in activities for which a special fee is assessed. Inquiries pertaining to visiting scholars should be addressed to the department chairman concerned or the Dean of the Graduate School.

Postdoctoral Research

Scholars engaged in postdoctoral research often find it advantageous to use the resources of Duke University during the summer. The University welcomes

these visitors and makes living accommodations available to them during the summer sessions from May 9 to August 8. Persons desiring research privileges (library and/or laboratory) should request approval through the department in which the research interests lie or through the Graduate School.

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DUKE UNIVERSITY

OFFICE OF THE UNIVERSITY ARCHITECT
DEPARTMENT OF PHYSICAL PLANNING
JAMES A. WARD—DIRECTOR

JANUARY, 1978

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WEST CAMPUS

MEDICAL CENTER

CENTRAL CAMPUS

EAST CAMPUS

bulletin of
Duke University
1987-88

The Fuqua School of Business

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Duke University
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The Fuqua School of Business

The information in this bulletin applies to the academic year 1987-88 and is accurate and current, to the extent possible, as of August 1986. The University reserves the right to change programs of study, academic requirements, teaching staff, the calendar, and other matters described herein without prior notice, in accordance with established procedures.

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H. Keith H. Brodie, M.D., *President*
Phillip A. Griffiths, Ph.D., *Provost*
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Eugene J. McDonald, LL.M., *Senior Vice-President, Administration, and University Counsel*
William J. Griffith, A.B., *Vice-President for Student Affairs*
John J. Piva, Jr., B.A., *Vice-President for Alumni Affairs and Development*
William L. Green, Jr., A.B., *Vice-President for University Relations*
Joel Fleishman, LL.M., *Vice-President*
Stephen Cannada Harward, A.B., CPA, *Treasurer and Assistant Secretary*
J. Peyton Fuller, A.B., *Associate Vice-President and Corporate Controller*
Allison Haltom, A.B., *Secretary of the University*
Andrew G. Wallace, M.D., *Vice-Chancellor for Health Affairs*
Charles E. Putnam, M.D., *Vice-Chancellor for Health Affairs*
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Patricia C. Skarulis, M.A., *Vice-Chancellor for Information Systems*
R. James Henderson, M.Ed., *Associate Vice-President and Business Manager*

The Fuqua School of Business Administration

Thomas F. Keller, Ph.D., CPA, *Dean*
Richard Staelin, Ph.D., *Associate Dean for Faculty Affairs*
David L. Miller, Ph.D., *Associate Dean and Director of M.B.A. Programs*
W. Lee Noel, A.B., *Associate Dean for Business Affairs*
Gordon D. Soenksen, M.B.A. *Associate Dean for External Affairs*
Ray Watson, Ph.D., *Associate Dean for Executive Education*
James R. Bettman, Ph.D., *Director of Ph.D. Program*
Robert L. Dickens, M.S., CPA, *Director of Undergraduate Studies*
John P. Gallagher, Ph.D., *Director of the Computer Education Center*
Margaret A. Trauner, M.B.A., M.L.S., *Librarian*

Board of Visitors, The Fuqua School of Business

Dean Thomas F. Keller

The Fuqua School of Business Calendar

1987

August	
26-28	Orientation and registration
31	Fall classes begin
September	
7	Labor Day, classes in session
October	
17-20*	Fall break
November	
26-29	Thanksgiving break
December	
11	Classes end
14-19	Examination period

1988

January	
7	Spring classes begin
March	
5-13	Spring break
April	
19	Classes end
25-30	Examination period
May	
8	Commencement

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*Dates of the 1987-88 calendar are subject to change by the Provost of Duke University during the 1986-87 year.

A Message from the Dean

In his indenture establishing Duke University, James Buchanan Duke stated his desire that the University excel in the teaching of medicine, religion, and business. The Board of Trustees of Duke University, in 1969, established the Graduate School of Business Administration with a mandate to provide programs in management education of the highest quality. In 1980 the school was renamed to honor J. B. Fuqua of Atlanta, Georgia, who is a member of both the University's Board of Trustees and the school's Board of Visitors. Mr. Fuqua has supported the school through his generosity and his participation in its programs.
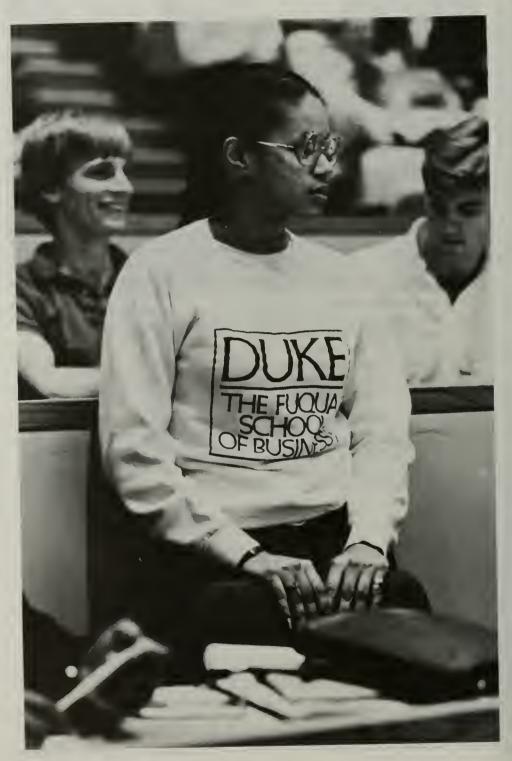
The mission of the Fuqua School of Business is to enhance the practice of management through education and research. Our approach is to prepare men and women to meet their career opportunities with a strong educational background and with an awareness of the need for initiative and leadership when faced with business challenges. We seek students who possess high academic standards and who also demonstrate the ability to think creatively. These are important qualities for business leadership and are reflected in the orientation of our entire program. As a school, we are committed to retaining our flexibility and our responsiveness to management needs as they arise in the business community.

Our heritage at Duke is a tradition of excellence in education. At the business school we have built on this heritage to develop programs which will enable graduates to meet the challenges of leadership in business, government, and educational organizations.

Thomas F. Keller
Dean

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Duke University

In 1839 a group of citizens from Randolph and adjacent counties in North Carolina assembled in a log schoolhouse to organize support for a local academy founded a few months earlier by Brantley York. Prompted, they said, by "no small share of philanthropy and patriotism," they espoused their belief that "ignorance and error are the banes not only of religious but also civil society which rear up an almost impregnable wall between man and happiness." Union Institute, which they then founded, was reorganized first in 1851 as Normal College to train teachers, and eight years later as Trinity College, a liberal arts college, which later moved to the growing city of Durham, North Carolina. With the establishment of the James B. Duke Indenture of Trust in 1924, Trinity College became Duke University. Today, Duke is a two-campus institution with a student body of about 9,000, of whom 3,000 are enrolled in the graduate and professional programs. Established in 1969, the Graduate School of Business Administration joined the Schools of Medicine, Nursing, Law, Engineering, Divinity, and Forestry in preparing qualified individuals for professional leadership and developing excellence in education for the professions.

The Campus. The main campus (West) of Duke University is a beautifully designed complex of buildings in Gothic architecture, bordered on the east by the Sarah P. Duke Gardens and on the west by the 8,000-acre Duke Forest. This campus is dominated by the Duke Chapel, whose 210-foot-high tower houses a 50-bell carillon. The William R. Perkins Library is one of the largest research libraries in the country. The new facility for the Fuqua School of Business is located on West Campus near the intersection of Science Drive and Towerview Drive. The East Campus is a smaller complex of Georgian-style buildings and has, as major points of interest, the Duke University Museum of Art and the Mary Duke Biddle Music Building.

Durham is a part of the Research Triangle, an area formed by Duke University, the University of North Carolina at Chapel Hill, and North Carolina State University at Raleigh. The Research Triangle Park, a 5,400-acre campus for research laboratories, governmental agencies, and research-oriented industries, is recognized as one of the world's leading science centers. Durham, located near the center of the state, has easy access to the Great Smokies of the Appalachian Mountains and to the scenic and historic beaches of the Outer Banks. The area offers varied cultural and recreational activities ranging from concerts, opera, dance, theater, and recitals to intramural and collegiate sports, boating, skiing, camping, and other outdoor activities.

The Fuqua School of Business. Recognizing the importance of business education, Duke University's Board of Trustees established the Graduate School of Business in 1969, with the mandate to provide management education programs of the highest quality. The school began with two programs; an undergraduate major in management science, and a fledgling M.B.A. Program that graduated its first class of twelve students in 1972. Since that time, the school has grown to include five major academic programs, a faculty of fifty-three, and over 500 masters degree candidates enrolled in daytime and executive M.B.A. programs. The school also offers a wide range of nondegree executive education programs and seminars.

J. B. Fuqua, Chairman of Fuqua Industries, Atlanta, Georgia, has supported the school generously in its development. In honor of Mr. Fuqua's contribution to the school and personal participation in its growth, the school was renamed the Fuqua School of Business in 1980 by proclamation of the Board of Trustees.

In January of 1983, the Fuqua School of Business moved into its new building on Science Drive on Duke University's West Campus. This building, designed by Edward Larrabee Barnes, offers one of the finest settings for management education in the United States. The 140,000 square feet of space provides for the instruction of M.B.A. students in a variety of degree programs as well as for year-round executive education programs.

The building is constructed in two wings. One wing, primarily designed for M.B.A. education, includes six amphitheatre-style classrooms, the 500-seat Harold S. Geneen Auditorium, a library completely devoted to management education, and numerous seminar and breakout rooms. The second wing is devoted to executive education, and features the R. J. Reynolds Executive Auditorium, dining and lounge facilities, and small group meeting rooms.

Resources of the University

The Library System. The libraries of the University consist of the Perkins Library and its eight branches on campus: Biology-Forestry, Chemistry, Divinity, the East Campus Library, Engineering, Music, Physics-Math, and the Undergraduate Library; and the Pearse Memorial Library at the Duke Marine Laboratory in Beaufort. Also located on West Campus are the Law Library and the Medical Center Library and Communications Center. In June 1985, these libraries contained approximately 3,460,000 volumes and ranked nineteenth in size among academic libraries in the United States. More than 10,000 periodicals, 11,000 serials, and 170 newspapers are received regularly. The collection includes about 7,450,000 manuscripts, 85,000 maps, 40,000 sheets of music, and 651,000 rolls or sheets of microtext.

The William R. Perkins Library. The William R. Perkins Library—the main library of the University—houses most of the books and journals in the humanities and social sciences, large files of United States federal and state documents, public documents of many European and Latin American countries, publications of European academies and learned societies, and special collections from South Asian, Far Eastern, and Slavic countries. The newspaper collection, with 90,000 reels of microfilm, has several long eighteenth-century files, strong holdings of nineteenth-century New England papers and antebellum and Civil War papers from North Carolina, South Carolina, and Virginia, as well as many European and Latin American papers. The manuscript collection of approximately five million items is particularly strong in all phases of life in the South Atlantic region. It also includes significant papers in English and American literature. The rare books collection contains materials covering a broad range of fields, and the Latin and Greek manuscripts constitute one of the outstanding collections in the United States. The collection of Confederate imprints is the largest in the country.

Tours of the Perkins Library are given frequently during orientation week and upon request throughout the year. Information about other campus libraries may be obtained from the staff in each of the libraries. Handbooks about library services and facilities are also available in each of the libraries.

Fuqua School of Business Library. Organized and established in January, 1983, the Fuqua School of Business Library supports the basic research and teaching of the Fuqua School. As a working collection, the library's materials and services are tailored to the needs of the students and faculty of the Fuqua School. As of June 1986, the library houses over 10,000 volumes of books, 300 current periodical subscriptions, a comprehensive business reference collection, as well as special collections, including annual and 10K reports on microfiche, computer software and documentation, and a working paper collection. Library services include computer-assisted research, a cooperative interlibrary loan program with neighboring universities, and a journal contents service. To assist M.B.A. students, librarians are available business hours Monday through Friday, while M.B.A. students trained in library research are available to assist library users during the evenings and on weekends.

During orientation week, the library has regularly scheduled orientation tours covering the library's collections and services. In addition, faculty and students may request library instruction tailored to a specific problem.

Computation Center. The Duke University Computation Center provides the University faculty and students with a facility for research and instruction. The center is presently equipped with an IBM 370/158 computer with 6,144 bytes of memory, four 3330-11 disk drives, twelve 3350 disk drives, six tape drives, two card readers, a card punch, four printers, and a digital plotter which is connected by a high-speed microwave link to one IBM 3081 (with sixteen million bytes of memory, multiple 3330- and 3350-type disk facilities, thirteen tape drives, drums, card readers, and printers) located in the Research Triangle Park at the Triangle Universities Computation Center (TUCC), a nonprofit corporation formed jointly by Duke University, North Carolina State University at Raleigh, and the University of North Carolina at Chapel Hill. TUCC also has two Hewlett-Packard 2000F computers which provide BASIC interactive computing. Duke has four medium-speed terminals (card reader and printer), located in the Engineering Building, the Biological Sciences Building, and the Sociology-Psychology Building, and on East Campus, as well as several other low-speed keyboard terminals, connected to TUCC.

All users of the Computation Center facilities are urged to obtain funds to pay for computer services. Users unable to obtain grant funding may ask for financial support from their departments when applying for services. More specific information regarding Duke computing facilities may be obtained from the Director of the Computation Center.

Fuqua School of Business Computer Education Center. Ever since the first architectural sketch of the building was drawn, the concept of an electronic business school has been at the leading edge of planning for the Fuqua School. The goal was a total computer network, and the dream was realized when the Computer Education Center opened in the fall of 1983. The foundation of the school's new electronic environment is a three-year joint study with the IBM Corporation. Within the framework of this study, the Fuqua School faculty and students use two IBM mainframes (the System/38 and the 4341) and 42 IBM personal computers to develop new curriculum materials and integrate computerized decision support systems into the M.B.A. educational programs. Classrooms, team rooms, the auditoriums, library, and faculty and staff offices have been constructed to facilitate this technological revolution.

Programs of Study

The Master of Business Administration Programs

The Duke M.B.A. Program prepares individuals for challenging management jobs in the private sector. The program emphasizes the understanding and application of analytical tools and concepts drawn from a broad array of management fields of inquiry. The student is asked to structure unstructured situations and to propose solutions to complex problems. By studying analytical tools, theories, and examples, the student learns to identify the common threads in seemingly different business situations and to grasp the essential nature of unfamiliar management problems.

The teaching styles adopted by the faculty vary. In some courses, lectures are the rule. In others, the case method predominates. In still others, there is a mix of many styles, including role playing and student presentations. Depending on the course, the work done outside of class is likely to consist of (1) reading texts or articles, (2) working problem sets, (3) researching and writing papers, or (4) preparing cases and discussing them in small study groups.

The school has made a deep commitment to the use of the computer in business education. Students are required to master word processing, spreadsheet programs, and some statistical packages on IBM Personal Computers. A number of courses require the use of these newly developing managerial skills. Likewise, the school is also committed to improving the communications skills of its students. The business communications curriculum does not stand by itself, but has been carefully integrated into other course work.

In these ways and others, the school is determined to stay in the forefront of business education.

OUTLINE OF THE CURRICULUM

The M.B.A. degree requires four semesters of full-time work totaling 63 units of graduate course credit. Students who are exceptionally proficient in a particular subject will be allowed to substitute advanced course work for one or more core courses. There are no summer sessions for students in the M.B.A. program.

Modern management often requires analytical reasoning which focuses on precise statements of relationships between variables. In contemplating the future, concepts of probability become especially important. For these and other reasons much of our course work assumes a firm grasp of mathematical concepts. We strongly encourage each applicant to come prepared with the necessary background. A working knowledge of calculus is essential. Evidence of this preparation is required for admission.

The First-Year Program. Course work in the first year is designed to provide the basic knowledge and tools of analysis for the operations of business organization. In the second semester of the first year, students are introduced to the functional areas of the firm. The first-year program includes:

Fall Semester

BA 300	Managerial Economics	3 units
BA 311	Statistical Analysis for Management	3 units
BA 312	Quantitative Analysis for Management	3 units
BA 320	Organization Behavior	3 units
BA 330	Financial Accounting	3 units
BA 318	Computer Laboratory	1 unit
		16 units

Spring Semester

BA 301	Economic Environment of the Firm	3 units
BA 331	Managerial Accounting	3 units
BA 350	Financial Management	3 units
BA 360	Marketing Management	3 units
BA 370	Operations Management	3 units
BA 388	Business Communications	2 units
		17 units

The Second-Year Program. The second year of the M.B.A. program consists of one required course and nine electives. The required course, BA 340, Business Policy and the Management Experience, stresses the application of knowledge gained in the first year to the overall management process, to the integration and

coordination of various functions, and to strategy formulation and implementation. One feature of the course is the play of a management game. The game places teams of students in key management positions of firms which compete in a simulated market environment. Student teams are responsible for the organizational structure and decision making in marketing, production, finance, and personnel. Each student team reports to a board of directors composed of faculty and business executives from the community.

The nine electives allow the students to develop additional depth in functional areas and freedom to concentrate their studies in a specific area of interest. Of the elective courses, one must be chosen from the environmental field which deals with the managerial implications of the economic, legal, social, and political environment of the firm. The courses satisfying this requirement are BA 302, BA 342, and BA 345. Students enrolled in the M.B.A./J.D. program are exempt from this requirement. The student may also elect up to four courses from other graduate and professional schools at Duke, or neighboring institutions in a reciprocal agreement with Duke. This allows the development of an individual program consistent with career goals.

The second-year program includes:

Fall Semester

BA 340	Business Policy and the Management Experience	3 units
	Electives	12 units
		15 units

Spring Semester

Electives	15 units

M.B.A. with an Accounting Concentration

Thanks to extensive financial support from the major public accounting firms, the Fuqua School of Business offers an M.B.A. degree with a concentration in accounting. Although Fuqua School students are not required to designate a major as part of the completion of the M.B.A. degree, those interested in professional careers in accounting may choose to concentrate in this area. Students who elect to pursue the concentration in accounting usually do so with the intent of entering the accounting profession and taking the CPA exam immediately after the completion of their degree. Certified Public Accountants are licensed by individual states, all of which use the Uniform CPA Examination. This entry level examination necessitates that students take a specified curriculum in order to be adequately prepared. Additional course requirements may be imposed by specified states for licensing in addition to those courses in the accounting concentration. Students enrolling in the program should determine the particular licensing requirements of the individual states in which they are interested in residing.

The Doctor of Philosophy Program

The Ph.D. in Business Administration Program prepares candidates for research and teaching careers at leading educational institutions and for careers in business and governmental organizations where advanced research and analytical capabilities are required. The Ph.D. program places major emphasis on independent inquiry, on the development of competence in research methodology, and on the communication of research results. Students are introduced at the outset of the program not only to rigorous course work, but also to the research

activities of the faculty and of other students. (A ratio of doctoral students-in-residence to faculty of less than one to one facilitates this opportunity to work closely with faculty.)

The program requires that doctoral candidates must acquire expertise in three disciplines: economics, behavioral science, and quantitative methods. In addition, each candidate must acquire knowledge at the M.B.A. level of at least three of the following functional areas: accounting, finance, marketing, and operations management. Competence in the three disciplines and the functional areas may be gained from the student's choice of course work, participation in seminars, and independent study. Each student takes a comprehensive exam at the end of the second year or the beginning of the third year of residence. The final requirement is the presentation of a dissertation. The Ph.D. program usually requires four years of work beyond the bachelor degree. Students entering the program with an M.B.A. or other advanced work may be able to reduce the time in residence. The student and his/her faculty committee determine the specific program of study, subject to the approval of the Director of the Doctoral Program.

The Ph.D. program currently emphasizes research and training in the areas of marketing, behavioral sciences and organizational theory, finance, accounting and quantitative methods, operations management, and regulatory economics. Other areas of emphasis will be developed as faculty are added to the staff of the Fuqua School of Business.

It is the policy of the school to provide fellowships to most new Ph.D. students. The school normally continues to provide financial support for up to thirty-six months as long as the student continues to make satisfactory progress toward the Ph.D.

The Ph.D. in business administration is a degree of the Graduate School of Duke University. Application forms should be obtained from and returned to the Director of Admissions, The Graduate School, Room 127, Allen Building, Duke University, Durham, North Carolina 27706.

Special Programs

CONCURRENT DEGREE PROGRAMS

The Fuqua School of Business offers combined degree programs with the School of Law, the School of Forestry and Environmental Studies, and the Institute of Policy Sciences and Public Affairs. By recognizing certain areas of study common to the M.B.A. and each of the other advanced degrees, duplication of instruction is eliminated and students are able to obtain the concurrent degrees in less time than would normally be required to obtain the two degrees separately. Students are normally required to take 51 units of business administration course work following admission to the program.

The M.B.A.–J.D. The concurrent M.B.A.–J.D. program requires four academic years of study with a full year in each school and two years of combined study that meets the requirements for both the M.B.A. and J.D. degrees. Students must apply for admission and be accepted by both the School of Law and the Fuqua School of Business. Additional information on the program may be obtained from the Director of Admissions, the Fuqua School of Business, Duke University, and the Admissions Office, Duke University School of Law.

The M.B.A.–M.F. and the M.B.A.–M.E.M. The concurrent Master of Business Administration and Master of Forestry or Master of Environmental Management degrees normally require three years of study. Students must apply for admission and be accepted by both the School of Forestry and Environmental Studies and the Fuqua School of Business. Additional information on the pro-

gram may be obtained from the Director of Admissions, the Fuqua School of Business, Duke University, and the Director of Admissions, Duke University School of Forestry and Environmental Studies.

The M.B.A.–A.M. in Public Policy Sciences. The concurrent Master of Business Administration degree and Master of Arts degree in Public Policy Sciences normally requires two and a half to three years of study. The joint degree curriculum requires a minimum of thirty credits to be specified by the Institute of Policy Sciences and Public Affairs, and fifty-one credits to be specified by the Fuqua School of Business. Students must apply to and be accepted by both the Fuqua School of Business of Duke University and the Graduate School of Duke University. Additional information may be obtained from the Director of Admissions, the Fuqua School of Business, Duke University, and the Director of Graduate Studies, Institute of Policy Sciences and Public Affairs.

Public Policy Option. For those students interested in management careers in the public or not-for-profit sectors the Fuqua School of Business offers a public policy option. This option consists of a recommended set of M.B.A. elective courses to be taken in the Institute of Policy Sciences and Public Affairs. Students interested in pursuing this option must obtain the consent of the institute's faculty adviser of M.B.A. students and the consent of the M.B.A. program director.

COMBINED UNDERGRADUATE-PROFESSIONAL DEGREES

Also known as the "three-two" program, the combined undergraduate-professional degree program provides that the Bachelor of Science or Bachelor of Arts degree may be awarded to students who successfully complete three years in an approved curriculum in arts and sciences at Duke and also the first year of study for the Master of Business Administration. After two years at Duke and before transfer to the Fuqua School of Business, students may apply for the three-two program through their academic dean. To be eligible for the combined program a student must successfully complete all baccalaureate requirements (except eight elective courses) and be admitted to the business school. Upon satisfactory completion of the first two semesters in the Fuqua School of Business, the student will be awarded a baccalaureate degree. The M.B.A. degree is awarded upon completion of the second year of the program.

EXECUTIVE M.B.A. EVENING PROGRAM

The Fuqua School of Business offers an M.B.A. degree for practicing managers in the greater Raleigh-Durham area. The program is designed for those who are seeking a broad educational base as preparation for more senior managerial positions, while continuing full-time job responsibilities. Major objectives of the program are to improve decision-making and management skills, and the effective utilization of these skills in resolving contemporary management problems.

The Executive M.B.A. Evening Program requires twenty-five months of study and includes six semesters of course work. Students interested in the program should contact the Director of the Executive M.B.A. Evening Program or the Director of Admissions, Fuqua School of Business, Duke University.

EXECUTIVE M.B.A. WEEKEND PROGRAM

The Fuqua School of Business also offers an Executive M.B.A. Weekend Program. The program is tailored to fit the schedule of the fully employed business executive who wishes to complete an M.B.A. degree without career interruption. It offers mature executives a broad perspective on general management responsibilities and includes the tools, concepts, and strategies required for senior leadership.

The Executive M.B.A. Weekend Program begins with an orientation program, and then meets Friday-Saturday every other weekend. The program requires twenty months of study and includes five semesters of course work. Students interested in the program should contact the Director of the Executive M.B.A. Weekend Program or the Director of Admissions, Fuqua School of Business, Duke University.

EXECUTIVE EDUCATION

The Fuqua School of Business offers a series of executive education programs designed for senior level executives. The programs vary in length from one week to four weeks and are tailored to the requirements of the participating group. The programs are residential, giving participants maximum involvement with each other and with the faculty. Major programs include a four-week Advanced Management Program and two-week programs in Strategic Human Resources Management, The Management of Capital Expenditures in the Telecommunications Industry, Executive Program for Corporate Counsel, and Strategic Production Management. Other recent offerings have included programs in cash management, and management of technology and innovation.

Further information on the school's executive education programs may be obtained from the Associate Dean for Executive Education, Fuqua School of Business, Duke University.

Admissions

Admissions

Anyone who holds a bachelor's degree from an accredited college or university is eligible to apply for admission to the Fuqua School of Business. No specific undergraduate major is deemed preferable to any other; however, the programs have been designed primarily for persons with training in the liberal arts, engineering, or the sciences. The Admissions Committee seeks those candidates with leadership potential who are prepared to compete successfully in a demanding course of study which requires logical and analytical reasoning. All entering students are expected to have a working knowledge of calculus, and applications are reviewed closely for this ability.

Prior work experience is not considered a requirement for the M.B.A.; however, the Admissions Committee recognizes the value of full-time work experience and considers it a positive factor in admission decisions.

Application Information. Complete instructions for filing an application are included with each application packet. Each applicant must submit the following to the Admissions Office before action can be taken:

1. Application Form: Careful completion of the application will ensure a thorough evaluation. Since it is desirable that the application be as complete as possible, additional sheets should be used if necessary.
2. College Transcripts: An official transcript from each of the colleges *attended* must be sent to the Admissions Office. Students who apply during their senior year must ensure that a final transcript be received by the business school prior to enrolling.
3. Letters of Recommendation: Three letters of recommendation are required and must be sent to the Admissions Office. Recent graduates or those in their senior year should have at least one letter submitted from persons familiar with their academic ability. Recommendations should be academic or professional, not personal.
4. Graduate Management Admission Test: Score reports must be sent directly from the Educational Testing Service to the Fuqua School of Business.
5. Application Fee: A nonrefundable fee of $45 to cover processing must be submitted with the application.

Any questions or requests for application materials should be addressed to the Director of Admissions, The Fuqua School of Business, Duke University, Durham, North Carolina 27706, telephone (919) 684-5874.

Application Deadline. A continuous admissions policy is followed in the Fuqua School of Business in that admission decisions are made as applications are completed. Generally, applications will be reviewed and given a decision approximately six weeks after receipt. Application credentials should be on file in the school by April 1. The application file must be complete before action can be taken. A limited number of places in the class are available for applications completed after April 1; therefore, those wishing to apply after the normal deadline may do so, but it is to an applicant's advantage to apply early.

Notification of Status. When the applicant has been accepted, a letter of admission and an acceptance form will be sent. A nonrefundable tuition deposit of $400 will be required to reserve a place in the class. The process of admission is not complete until the statement of acceptance and the tuition deposit have been returned to the Director of Admissions.

Applicants notified of acceptance prior to March 15 will be expected to make the $400 tuition deposit by April 15. Applicants notified of acceptance after that date will be expected to make the tuition deposit within three weeks of the notification, or the place in the entering class will be forfeited. It should be reiterated that the tuition deposit is in all cases nonrefundable.

Graduate Management Admission Test. The Graduate Management Admission Test, required of all applicants, is administered by the Educational Testing Service. Detailed information about the test and application forms may be obtained by writing directly to the Educational Testing Service, Box 966, Princeton, New Jersey 08540.

The examination is administered at many centers throughout the United States and abroad. Arrangements to take the test at an established center must be made four weeks before the test date (six weeks prior to test date at established foreign centers). The examination is given four times a year. Special centers may

be arranged for persons distant from established centers. Requests for such accommodations must be made at least eight weeks prior to the selected test date. Applicants are encouraged to take the test in October or January; those taking the test in March or June run the risk of having the class already filled by the time scores are available.

Admission of Foreign Students. Fully qualified students from outside the United States are welcome at the Fuqua School of Business. In applying for admission, the foreign student should submit, in addition to the above credentials, the following:

1. If the native language is not English, the results of the Test of English as a Foreign Language (TOEFL) must be submitted. Most successful applicants score approximately 600 or better on the TOEFL.
2. A statement certified by a responsible person that finances are sufficient to maintain the student during the stay at Duke University. The University does not at the present have fellowship or loan programs for foreign students.
3. A statement by a qualified physician describing the physical and mental health of the applicant.

The M.B.A. program is a two-year program and all students are expected to complete the required course work in the allotted time period. Foreign applicants should be prepared to carry the normal course load as described earlier in the bulletin. For this reason, applicants whose native language is not English should consider the merits of attending an intensive English language program or enrolling in summer school courses at a university in the United States prior to enrolling at Duke. Since the course work in the program will involve lectures, discussions, and group projects, a firm understanding of the language is required.

Tuition and Fees

The tuition for students in the Fuqua School for the year 1986-87 is $5,700 per semester. All charges are due and payable at the times specified by the University and are subject to change without notice. A late registration fee of $25 is charged any student not completing registration during the registration periods. An $8 charge will be imposed for any student's check returned to the University unpaid.

After the beginning of classes, refunds will be made on a pro rata basis. Students may elect to have tuition charges refunded or carried forward as a credit for later study according to the following schedule:

1. Withdrawal before classes begin: full refund.
2. Withdrawal during the first or second week of classes: 80 percent.
3. Withdrawal during the third, fourth, or fifth week of classes: 60 percent.
4. Withdrawal during the sixth week: 20 percent.
5. Withdrawal after the sixth week: No refunds.

Tuition or other charges paid from grants or loans will be restored to those funds not refunded or carried forward.

If for any reason during the program, a student should find it necessary to request a reduction in the normal course load, this request will be reviewed by the Program Director. If the Program Director approves a reduction in the course load, the student has the right to request a corresponding reduction in his/her tuition charges. These requests will be considered only for those students for whom the course reduction will necessitate enrollment in the Fuqua School in excess of four semesters for M.B.A. students or six semesters for Executive M.B.A. students. Students receiving approval for a tuition reduction will be charged on a pro rata basis.

Payment of Accounts. Duke University does not have a deferred payment plan for tuition, fees, and other charges. Following first enrollment in the Fuqua School, monthly invoices are sent each student by the Bursar's office. As a part of the agreement of admission to Duke University a student is required to pay all invoices as presented. A late payment charge will be assessed for all charges not paid in full by the due date, and certain restrictions may be applied. All students are charged the student health fee and student accident and sickness insurance coverage unless they file properly completed and signed waivers in the Bursar's office by the invoice due date.

Late Payment Charge. If the total amount due on the student's invoice is not received by the Bursar by the invoice due date, a penalty charge will be accrued

from the billing date of the invoice. The late payment charge is assessed at a rate of the 1 1/3 percent per month (16 percent per annum) applied to the past due balance. The past due balance is defined as the previous balance less any payments and credits related to the previous balance which appear on the invoice.

Restrictions. An individual will be in default if the total amount due is not paid in full by the due date. A student in default will not be allowed to receive a transcript of academic records, have academic credits certified, or receive a diploma at graduation. In addition, an individual in default may be subject to withdrawal from school.

M.B.A. Association Student Activity Fee. All students are assessed a $25 nonrefundable fee to be used to support the activities of the M.B.A. Association.

Athletic Tickets. Athletic ticket books are available to graduate students. Purchase is optional, with payment due in the fall semester.

Vehicle Fee. Each student possessing or maintaining a motor vehicle at Duke University shall register it at the beginning of the academic year in the Duke Public Safety Office at 2010 Campus Drive. A student who acquires a motor vehicle and maintains it at Duke University after academic registration must register it within five calendar days after operation on the campus begins. Resident students are required to pay an annual fee for each motor vehicle.

At the time of registration of a motor vehicle the following documents must be presented: state vehicle registration certificate, valid driver's license, and a student identification card.

Transcript Fee. Students who wish to obtain copies of their academic records should direct requests to the registrar's office, 103 Allen Building. Ten days should be allowed for processing. A fee of $1, payable in advance, is charged for each transcript copy.

Student Health Fee. All students are assessed a nonrefundable fee for the Student Health Service. The fee for 1986-87 is $202 ($101 per semester).

Student Accident and Sickness Insurance. The University has made arrangements for a Student Accident and Sickness Insurance Plan to cover all full-time students for a twelve-month period. For an additional fee a student may obtain coverage for a spouse and children. Although participation in this program is voluntary, the University requires all graduate students to be financially responsible for medical expenses above those covered by the University Student Health Program through the University Accident and Sickness Policy, a private policy, or personal financial resources. Students who have equivalent medical insurance or wish to accept the financial responsibility for any medical expense may elect not to take the Duke plan by signing a statement to this effect. *Each full-time student in residence must purchase this student health insurance or indicate the alternative arrangement.* The Student Accident and Sickness Insurance Policy provides protection twenty-four hours per day during the full twelve-month term of the policy for each student insured. Students are covered on and off campus, at home, while traveling between home and school, and during interim vacation periods. The term of the policy is from the opening day of school in the fall. Coverage, services, and costs are subject to change each year as deemed necessary by the University. The rates for 1986-87 are estimated at : student only—$250 per year; and family plan (student, spouse, and children)—$700 per year.

Living Expenses. The estimated living costs for the 1986-87 academic year are $6,563 for a single student and $10,759 for a married student. These estimates include room and board, and allowances for transportation and miscellaneous personal expenses.

Debts. No records are released until students have settled with the Bursar for all indebtedness. Failure to pay all University charges on or before the times specified by the University will bar the student from class attendance until the account is settled in full.

Students are expected to meet academic requirements and financial obligations, as specified elsewhere in this bulletin, in order to remain in good standing. Certain nonacademic rules and regulations must be observed also. Failure to meet these requirements may result in dismissal by the appropriate officer of the University.

Financial Aid

The Fuqua School of Business endeavors to make it possible for qualified students to attend Duke even though their own resources may be insufficient. Financial aid is available in the form of fellowships and various loan programs. Applicants are expected to make use of personal savings, veterans' benefits, summer income, and loans from family and other outside resources prior to requesting aid.

The Fuqua School of Business Fellowships. Each year a number of fellowships are available to incoming students. In general, the criteria for selection are prior academic achievement, demonstrated qualities of leadership, involvement in extracurricular activities and professional accomplishments. The awards are for two years of graduate study, ranging from partial tuition to full tuition. Requests for fellowships should be filed no later than March 1 to receive full consideration.

Named Gift Fellowships. The following awards are among the named gift fellowships offered by the Fuqua School of Business.

Accounting Associates Fellowship. These fellowships were established in 1976 through the donation of the Accounting Associates, a partnership of Duke University accounting professors. These awards are given annually to M.B.A. students pursuing an interest in accounting.

Junior Achievement Scholarships. A grant from the Little Family Foundation supports two awards annually having a stipend of $5,000 each. These scholarships are given to persons who have participated actively in a Junior Achievement Company or who have worked as an adviser to a Junior Achievement Company. First preference is given to company participants who have two or more years of full-time work experience; second preference is given to advisers who have two or more years of work experience; and final preference is given to participants who do not have work ex perience.

Martin L. Black Fellowships. Established in 1974 through the gifts and donations of alumni and friends of Martin L. Black, Professor Emeritus and a faculty member in accounting at Duke for over forty years, these fellowships are awarded to M.B.A. students who plan to concentrate in accounting.

Mead Scholarship. These scholarships, established in 1977 by the donation of Mr. D. Richard Mead, Jr. (A.B., 1952), are given to students who, without such support, might otherwise not be able to afford the cost of continued graduate study.

P. Huber Hanes Scholarships. Established in 1939, through the donation of Mr. P. Huber Hanes, these scholarships are given annually to two Duke students admitted by the Fuqua School into the combined undergraduate-professional degree program (also known as the "three-two" program). One scholarship is given in the name of P. Huber Hanes and one is given in the name of P. Huber Hanes, Jr. These scholarships are given to students who have excelled academically and extracurricularly.

Wachovia Scholarships. These scholarships are awarded to students who show promise of academic excellence and leadership potential. They were established in 1975 by Wachovia Bank and Trust Company.

Loan Programs. The Fuqua School operates long-term loan programs and participates in the college work-study program. These programs are available to students who anticipate a need to supplement personal resources while attending school. Students who demonstrate need according to federal guidelines and information supplied on a Graduate and Professional School Financial Aid Service (GAPSFAS) form, are eligible to participate in these programs.

Guaranteed Student Loans (GSL). The Guaranteed Student Loan Program, sponsored by the U.S. Department of Education, enables graduate students who qualify on the basis of need to borrow up to $5,000 per academic year. These funds may be borrowed directly from a bank, credit union, savings and loan association, or other participating lender. The current interest rate for new borrowers is 8 percent which is subsidized by the federal government while the student maintains full-time enrollment. The maximum repayment period is ten years with repayment beginning six months after graduation or the cessation of full-time enrollment.

Specific information regarding the operation of the program in the applicant's home state and necessary application forms may be obtained from local banks or state agencies. Students with a certified need who are unable to secure a guaranteed loan from a financial institution in their home state may be granted a GSL loan through Duke University.

National Direct Student Loans (NDSL). The National Direct Student Loan (NDSL) program is a federally funded, campus-based aid program with funding being

awarded on the basis of need. The NDSL program is a low-interest (5 percent) program which is fully subsidized by the federal government during the student's period of enrollment. Repayment of principal and the assumption of 5 percent interest begin six months after the termination of enrollment on at least a half-time basis. Federal law limits graduate students to a maximum borrowing capacity of $12,000, inclusive of undergraduate borrowing. These loans are awarded by the Financial Aid Office and are part of a student's loan package.

PLUS/ALAS Program. The PLUS/ALAS Program is a federally approved loan program for parents of undergraduates and for independent graduate and professional students. The maximum annual loan under this program is $3,000, with an aggregate limit of $15,000 for each student. The maximum interest rate on these loans is tied to the 91-day Treasury-bill rate and is currently at 12 percent. Full-time student borrowers under the PLUS program can defer principal repayment while in school, however interest accrual and repayment begins immediately after the note is signed. The treatment of interest payments may vary according to lender policies. Students with a certified need who have difficulty finding a lender may be able to borrow through Citibank which has a special agreement with Duke.

GradEd Financing. This is a new private educational loan plan specifically designed for full or half-time graduate students pursuing an advanced degree in engineering, law, health professions or business administration. Qualified students may borrow $1,500 to $7,500 per academic year, up to a total of $15,000. Total indebtedness when combined with other student loans may not exceed $45,000. The interest rate is a variable rate equal to Treasury bill plus 3.5 percent, and students may opt for a flexible, graduated payment plan upon graduation. Students have up to 15 years to repay, depending on the amount of their outstanding loans under the GradEd plan, with only minimum monthly payments of accrued interest (or $50, whichever is greater) while in school. Full-time students may defer payment of principal and interest for up to four years with a qualified co-maker.

College Work-Study Program. The College Work-Study Program is federally funded and supports the employment of students while they are in school. Students must meet federal need standards to qualify for participation. With work-study, a student's salary is paid jointly by the federal government and the Fuqua School. Funding from this program is available only for students employed by the Fuqua School. Students given work-study allocations are responsible for securing their own employment within the school, which offers a variety of employment opportunities for interested students.

Financial Aid Application. Financial aid decisions are made as applications are completed, with the first awards being granted beginning in late February. All students applying for financial aid must complete the Financial Aid Application and a GAPSFAS form. The GAPSFAS application may be obtained from the Graduate and Professional School Financial Aid Service, Box 2614, Princeton, New Jersey 08540, and should be filed no later than February 1, in order to ensure its arrival at Duke by March 1. Applications received by March 1, including receipt of the GAPSFAS, will be assured of full consideration for all available resources. Federal law requires verification of income data submitted prior to January 1. Students are therefore encouraged to delay GAPSFAS filing until after January 1. The GAPSFAS contains sections to be completed by the applicant, by the spouse or spouse-to-be, and by the applicant's parents. Applicants who will not be considered independent by federal standards must have the parents' questionnaire section completed. All financial aid applicants are required to provide a *signed copy of their most recent income tax statement* before any loans can be processed. Dependent students must also include a copy of their parents' income tax statement.

Career Services and Placement

The Office of Career Services and Placement initiates a comprehensive program of career planning early in the first year of study. It is recognized that students enter the program with varying degrees of career maturity depending on previous education and experience. Therefore, the career planning program is organized to meet a wide range of developmental needs.

Activities conducted by the Placement Office staff offer the opportunity to move through a logical progression beginning with self analysis, followed by preparation for placement and the summer job search and finally focusing on sophisticated career decision making as it relates to the world of work. The methods used to deliver these services include individual advising sessions, small group and workshop presentations and required large group lectures and seminars.

In the self analysis process, instruction is given and materials are used to allow the student to identify, qualify, and quantify individual skills, interests, and abilities in an in-depth manner. Once defined, these skills and abilities become the foundation for resume writing and the interview process.

Much attention is given to the development of a solid set of credentials and the preparation of personal references. To assure quality resume construction, students attend an instructional session, participate in a resume writing workshop, and receive individual critiques from placement professionals. Upon resume completion, focus is shifted to developing strategies for the job search process beginning with summer internship.

The Placement Office offers opportunities for meaningful summer employment between the first and second year of study through employer interviews on campus, employer referrals to the placement staff and the development of individually guided strategies.

During the second semester, synthesis between skills, interests and abilities, and occupational and career choices is encouraged. To accomplish this, an intensive multiple session workshop for students interested in further career development and decision making is conducted. Additionally, several panels utilizing area professionals and alumni address a variety of career fields and skills, abilities, and experience needed to pursue those careers.

The culmination of the self analysis, job search, and decision making activities followed by the summer internship permits students to begin the second year of study with well developed career decisions prior to the ultimate job search. Since both summer and permanent on-campus recruiting occur only in the spring semester, the office provides ample opportunity

for student interface with the corporate community during the fall term.

The Fuqua School's annual Job Fair provides an excellent opportunity for students and employers to discuss job prospects and career responsibilities in a relaxed and informal atmosphere. Second-year students focus on specific careers within a specific industry or company while the first-year class usually gathers as much information as possible on career alternatives. As a result of the program, many students arrive at early decisions concerning their area of interest. The types of firms represented are broad based to offer a variety to the student.

Special Interest Programs (SIPS) allow the employer a more focused setting in which to talk about job opportunities. These programs are usually held late in the afternoon in one of the building's lounges, and usually include a light buffet. The format is very flexible and informal. Most sessions open with prepared remarks or an audio-visual presentation, followed by a question and answer period. The program promotes a mutual give and take situation between students and employers.

The Placement Office also cosponsors programs and events in cooperation with student organizations.

1985-1986 Participating Companies

Air Products & Chemicals, Inc.
Allied Corporation
Amerada Hess Corp.
American Airlines
American Express Travel Related Services Co.
American Management Company
American Medical International (AMI)
Arthur Andersen & Co.
Arthur Young & Co.
AT&T Communications
AT&T International
A. T. Kearney, Inc.
Bank of America
Bank of New York
Bankers Trust Company
Barclays American
Benton & Bowles, Inc.
Bill Communications
Biosponge Aquaculture Products Co.
Booke & Company
Booz, Allen & Hamilton, Inc.
Borg Warner Corporation
Brady Trane Service
Burger King Corporation
Burke Marketing Services, Inc.
Burlington Industries, Inc.
Burroughs Corporation
Burroughs Wellcome Company
Campbell Soup Company
Campbell Taggart, Inc.
Capital South
Carnation
Carolina Freight Carriers
Carolina Power & Light Company
Chase Manhattan Bank, N.A.
Chemical Bank
Chicago Board of Options Exchange
Chris C. Crenshaw Associates
Chrysler Corporation
CIGNA Corporation
Coastal Group, Inc.
Combustion Engineering Company
Computer Circuitry Group

Connecticut National Bank
Consolidated Health Care, Inc.
Continental Illinois Bank
Control Data Corporation
Corning Glass Works
Cryovac, Division of W. R. Grace & Co.
Data General Corporation
Dean Witter Reynolds, Inc.
Deloitte Haskins & Sells
Drackett Company
Duke Power Company
Duke University
Duke University Medical Center
Duke University Tel-Com
Durham Herald Company
Durham Research Properties
Eastman Kodak Company
Eaton Company
Eisai Co., Ltd.
Electronic Data Systems Corp.
Eli Lilly & Co.
Ellison Company
Emerson Electric Company
Energy Management Assoc., Inc.
Ernst & Whinney
Ethyl Corporation
Exxon Co., U.S.A.
Fairmont Hotels
Federal Express
Federal Home Loan Mortgage Corp.
First Boston Corporation
First Commercial Brokers
First Interstate Bank
First National Bank of Maryland
First Union National Bank
Florida Power & Light Co.
Ford Motor Company
Frito-Lay, Inc.
FSLIC
Fuqua Industries, Inc.
General Electric Company
General Electric Credit Corporation
General Foods Corporation

General Mills, Inc.
General Motors Corporation
Glaxo, Inc.
Goldman, Sachs & Company
GTE of the South
H. J. Heinz Company
Hallmark Cards, Inc.
Hanes Group
Hanes Knitwear
Harris Corporation
Hewitt Associates
Hewlett-Packard
Hospitality Valuation Services
IBM Corporation
IBM World Trade Corporation
Ingersoll-Rand
Intech Corporation
Integon Corporation
Irving Trust Company
Jennings, Ryan, Federa & Co.
Joseph E. Seagram & Sons, Inc.
Key Homes, Inc.
Kraft, Inc.
Lee-Moore Oil Company
L'Eggs Brands, Inc.
L'Eggs Products, Inc.
Leo Burnett
L. F. Rothschild, Inc.
Manufacturers Hanover Trust Co.
Marine Midland Bank, Inc.
Mark Twain Bancshares, Inc.
Maryland National Bank
Massachusettes Mutual Life Insurance Co.
McCormick & Company, Inc.
MCI Mail
McKinsey & Company, Inc.
MCorp
Mellon Bank, N.A.
Merrill Lynch Capital Markets
Metropolitan Life Insurance Company
Michelin Tire Company
Microelectronics Center of N.C.
Miller Brewing Company
Milliken & Company
Mobil Oil Company
MONY Financial Services
Morgan Guaranty Trust Company
Morgan Stanley & Co., Inc.
Nabisco Brands, Inc.
North Carolina Biotechnology Center
NCNB Corporation
NCR Corporation
Needham Harper Worldwide
Newport News Shipbuilding
New York Yankees
Northern Telecom, Inc.
NYNEX

Oak Value Partners
Paine Webber, Inc.
Peat, Marwick, Mitchell & Co.
Pepsico
Personal Products Company (Johnson
    & Johnson)
Peterson, Howell & Heather, Inc.
Philadelphia National Bank
Philip Morris Companies, Inc.
Pinnacle Group
Pittsburgh National Bank
Planning & Design Associates
Planters Bank
Price Waterhouse
Proctor & Gamble Company
Prudential Bache Securities, Inc.
R. J. Reynolds Corporation
R. R. Donnelley & Sons Corp.
Riggs National Bank of Washington, D. C.
Roadway Express, Inc.
Rochester Telephone
Rockwood Holding Company
Russell Corporation
Ryder System, Inc.
Salomon Brothers
Schneider Group of Companies
Scott & Associates
Scott Paper Company
Scripps-Howard
Seaboard Systems Railroad
Shearson Lehman Brothers, Inc.
Siecor Corporation
SKF, Inc.
Smith, Barney, Harris & Upham Co., Inc.
Smith Breeden Associates
Snackmaster (Division of M & M Mars)
Sonoco Products Company
Squibb Pharmaceutical Division
SSC & B Advertising
Stuart Pharmaceuticals
Summit Communications
Talton Telecommunications Corp.
Tenneco Oil Company
The Codman Company
Thomson McKinnon Securities, Inc.
Toll Brothers, Inc.
Touche Ross & Company
Towers, Perrin, Forster & Crosby
Trammel Crow Company
United Research Companies
USA Today
Vista Chemical Company
W. R. Grace & Company
Wachovia Bank & Trust Co., N. A.
Westinghouse, Inc.
Westvaco Corp.
Xerox Corporation

Living Accommodations

Duke University has several residential facilities in which single graduate and professional students reside; however, married student housing is not available. Married students should refer to the section entitled off-campus housing.

Town House Apartments. Town House Apartments, located about three blocks from the main East-West Campus bus line, is a thirty-two-unit complex, which houses single graduate and professional school students. These apartments are more spacious than most apartments found on campus or in Durham. Because of their location away from the academic facilities, students find that these apartments offer a change from normal campus life and activities. They are available for continuous occupancy throughout the calendar year.

Each air-conditioned apartment includes a living room, a master bedroom, a smaller bedroom, a bath and a half, and an all-electric kitchen with a dining area. Spacious closets and storage spaces are provided within each apartment. A swimming pool, located in the center of the complex, is open during the late spring and throughout the summer months.

Occupants must make arrangements with the local utility companies to pay for electricity, gas, and telephone service. These companies usually require a deposit when initial applications for service are made. Utility companies should be contacted prior to arrival as it usually takes several days to obtain service.

Central Campus Apartments. During 1975, Duke University completed a 500-unit apartment complex. Apartments are available throughout the calendar year for continous occupancy to single students attending graduate and professional school.

Located in the center of the complex is a swimming pool (open during the late spring and throughout the summer months), a convenience store, and a pub.

All Central Campus Apartments are completely furnished by the University. An itemization of furnishings is included with the floor plans sent out in the application packet.

All utilities—water, heat, air-conditioning, and electricity—are provided. Telephones, which are provided in preinstalled locations in each apartment, are services through Duke Universitie's Tel-Com telephone service. Central Campus Apartments' residents are responsible for having their phones connected.

Efficiency, two-bedroom, and three-bedroom apartments are rented to single students. Efficiency units are very limited in number and are generally not available to new students. Spaces in apartments for single students are provided on an

individual basis with each student paying rent per academic term to the University. This method permits students to share apartments with others of their choice. When this is impractical, the Department of Housing Management strives to place persons with similar interests together.

Modular Homes. Duke University owns six prefabricated modular homes which are located one block from the main East-West Campus bus line. Three of these three-bedroom homes are occupied by single graduate and professional students. The homes, completely furnished, provide more privacy than most apartments and are available to single graduate and professional students for continous occupancy throughout the calendar year.

In addition to having three bedrooms, each home contains a full bath, an all electric kitchen, a dining area, and a living room. Sliding glass doors in the living room open onto a wooden deck. An outside storage area is provided in addition to spacious closets within the home. Except for the bathroom, kitchen, and dining area, the homes are completely carpeted and paneled.

Residents of the modular homes are responsible for making arrangements with local utility companies for gas, electricity, and telephone services.

Application Procedures. When students are informed of their acceptance to the business school they will also receive a postcard on which to indicate preference for University housing. This postcard should be returned to the Department of Housing Management. Detailed information on the types of accommodations and application forms will be forwarded to the accepted student. Assignment to all University housing is made on a first-apply, first-assigned basis and is not guaranteed.

Off-Campus Housing. The Department of Housing Management maintains a listing of rental apartments, rooms, and houses provided by property owners or real estate agencies in Durham. These listings are available in the department only; during the summer an assistant is available to answer questions and aid students in their attempts to obtain housing off-campus. Information on commercial complexes in the Durham area may be obtained by indicating a preference for off campus housing on the postcard which you receive with your acceptance packet. Except for assuring that owners sign a statement of nondiscrimination, off-campus property is in no way verified and neither the University nor its agents negotiate between owners and interested parties.

The search for accommodations should begin as soon as possible after acceptance to the business school. A visit of two or three days will allow the opportunity to make use of the off-campus service and to inspect personally the availabilities.

Food Services

Duke University Food Services (DUFS) operates a variety of dining facilities including "all you can eat" cafeterias, a la carte restaurants, fast food facilities, salad bars, elegant seated dining restaurants, and an on-campus pizza delivery service.

Graduate and professional students may choose to pay for food purchases in cash, or they may opt to open a prepaid account. There are two accounts which a student may open—a food only dining plan and a flexible spending account. The flexible spending account may be used to purchase any food items sold by DUFS, any items sold in the University stores, and to purchase beer and wine, where available.

For more information about opening either a flexible spending account or a dining account, contact the Auxiliary Services contract office at (919) 684-5800.

In addition to the above University food services, the Fuqua School of Business has its own cash-only snack bar, The Kiosk, which serves a limited menu of light snacks, sandwiches, and beverages during normal business hours.

Other Services

Bus Service. Free on-campus bus service is provided by the University connecting East, West, North, and Central Campuses, Science Drive and intermediate on-campus locations. Bus service is also provided between Duke Manor and Chapel Tower Apartments and the campus, during the academic year only. Printed schedules are available at the Bryan Center Information Desk, the Housing Management service offices, and from the transportation office located at 712 Wilkerson Avenue, just off East Campus behind Brightleaf Square. Schedules are also posted at each of the major bus stops.

Route, schedule, and employment information is available weekdays by calling 684-2218.

University Stores. University Store operations on campus sell textbooks, school supplies, health and beauty items, room accessories, gifts, clothes, and food items. Items may be purchased with cash, check, Visa or Mastercard, or on the Duke Card flexible spending account (see description under Food Services).

The Bryan University Center is the location of four of the store's operations: the University Store sells school, office and computer supplies, and gift items with Duke University's official logos; the Duke University Bookstore sells textbooks, technical reference books, study aids, and computer software; the Gothic Bookshop stocks new fiction and nonfiction titles; and the Lobby Shop sells magazines, newspapers, health and beauty aids, and snack foods.

Student Activities

M.B.A. Student Association. The association serves as liaison between the students and faculty and administration in both academic and nonacademic matters. The structure of the association includes several standing and ad hoc committees dealing with concerns such as admissions and placement, computer and library facilities, intramural sports participation, alumni, and social events.

Cocurricular Activities. Graduate students at Duke University are welcome to use such University recreational facilities as swimming pools, tennis courts, and golf course, and to affiliate with the choral, dance, drama, music, and religious groups. They may become junior members of the American Association of University Professors and may affiliate with Phi Beta Kappa and social fraternities.

A full program of cultural, recreational, and religious activities is presented by the Office of Cultural Affairs, the Duke University Parish Ministry, the Duke University Union, the Office of Student Activities, and recreational clubs. The Duke University Union sponsors a wide range of programs through its committees which are open to all segments of the campus community. Included are touring Broadway shows; rock, jazz, and pop concerts; speakers; films; a film-making program; the largest fully student-run television station in the country; art exhibits in two galleries; and a broad program in crafts located in Southgate Dormitory and the Bryan University Center.

The University Center complex includes the new Bryan University Center, which houses the Information Center, two drama theaters, a film theater, lounges, stores, meeting rooms, games room, rathskeller, art gallery, and other facilities; the West Union which includes dining facilities; and Flowers Building, which includes student publications, Page Auditorium, and the University box office.

Inquiries should be directed to the Intramural Office, 105A Card Gymnasium;

the Office of Cultural Affairs, 107 Page Building; Duke Chapel; the Duke University Union, Bryan University Center; or the Office of Student Activities, Bryan University Center.

Full information regarding the scheduling of major events and programs for the entire year will be found in the Duke University *Annual Calendar*; detailed and updated information for the fall and spring semesters in the *Weekly Calendar*, available each Friday; updated information for the summer session in the *Summer Session Calendar*, published at the beginning of each summer term; and the Duke *Chronicle*, published each Monday through Friday during the fall and spring and each Wednesday during the summer. Copies of the Duke University calendars may be obtained at the information desk, Flowers Building, or the calendar office, Page Building. Also during the summer, the *Summer Session Newsletter* is published weekly by the summer session office and is available at convenient locations.

Intramural and Recreational Sports. The Duke recreational and intramural programs provide all students with opportunities to participate in some form of healthful, informal, and competitive physical activity. In a typical year, more than 3,000 students compete for many intramural titles and trophies. Each year Duke, the University of North Carolina, North Carolina State, and Wake Forest meet in the annual Big Four Intramural Day.

The men's and women's intramural programs include many different activities (e.g., bowling, cross-country, golf, handball, horseshoes, tennis, flag football, badminton, racquetball, basketball, swimming, table tennis, volleyball, soccer, softball, and track). In addition, special events in other areas of interest are held. Various performing clubs, including one for water ballet, offer the student opportunities to take part in extracurricular activities. Through coeducational intramurals, the student is encouraged to participate on a less competitive level, promoting relaxed social and physical activity. Opportunities for competition between men and women are pro vided in areas that include archery, badminton, basketball, softball, racquetball, squash, table tennis, tennis, volleyball, and water polo.

The University's varied athletic and recreational facilities and equipment are available for use by students. The facilities for recreation include a golf course, lighted tennis courts, three swimming pools, squash and racquetball courts, three gymnasiums, a weight training room, outdoor handball and basketball courts, an archery range, horseshoe courts, an all-weather track, numerous playing fields, jogging and exercise tracks, and informal recreational areas. More than thirty sports clubs dealing with gymnastics, scuba diving, sailing, cycling, crew, riding, fencing, football, frisbee, ice hockey, kayaking, lacrosse, badminton, karate, rugby, soccer, and other activities are available to interested students.

Graduate and Professional Student Council. The Graduate and Professional Student Council is the representative body for the students of graduate departments and professional schools. The council provides a means of communication between schools and between graduate students and the administration. The council selects graduate students for membership on University committees. Representatives of each department and officers of the council are selected annually.

Religious Life. The Duke Chapel is open daily for prayer and meditation. The Sunday morning worship in the Chapel at 10:55 A.M. is the central focus for University religious life. The Chapel Choir is open to those who wish to sing in it. The Benjamin N. Duke Memorial Organ is played Monday through Friday from 12:30 P.M. to 1:30 pM. Special guest recitals are also scheduled. The ministers and other members of the Chapel and Religious Life staffs are available to provide counseling help and other assistance as needs arise.

Health Care

Medical Care. The aim of the Student Health Service is to provide any medical care and health advice necessary to the student as a member of the University community. The health service maintains the Student Health Services Clinic located in the Pickens Building on West Campus and the University Infirmary on the East Campus. Emergency transportation can be obtained by the Duke campus police. A separate fee for the Student Health Service is assessed.

The Student Health Service offers varied benefits. To secure them, full-time graduate students must be in residence; during the fall and spring semesters, they must be registered for at least 9 units per semester until they have passed the doctoral preliminary examination, after which they must be registered for at least 3 units in residence. During the summer, graduate students must be registered for at least 1 unit of research or 3 units of course work. The student health fee is nonrefundable after the first day of classes in the semester.

The Student Health Services Clinic offers the student outpatient services, routine laboratory and X-ray examinations in the clinic for the treatment of acute illness or injury, and advice and assistance in arranging consultation for medical treatments. Fees for such consultations or treatments must be paid by a student who is not covered by an insurance plan.

The facilities of the University Infirmary are available to all currently enrolled full-time students in residence during the fall and spring. Hospitalization in the University Infirmary is provided for treatment of acute illness or injury as authorized by the Student Health Services Clinic physician. Students are required to pay for their meals while confined to the infirmary.

The resources of the Duke University Medical Center are available to all Duke students and their spouses and children. Any bills incurred at Duke Hospital or any other hospital are the responsibility of the student, if not covered by an insurance plan. The Student Health Program does not provide health care for spouses and dependent children of married students. Coverage of the married student's family is provided in the University's Student Accident and Sickness Insurance Plan for an additional fee. Refer to the chapter, "Financial Information," for complete information on this plan.

Counseling and Psychological Services. CAPS provides a comprehensive range of counseling and psychological services to assist and promote the personal growth and development of Duke students. The professional staff is composed of clinical social workers, psychologists, and psychiatrists experienced in working with young adults. Among services provided are personal, social, academic, and career counseling. A number of short-term seminars or groups focusing on skills development and special interests such as coping with stress and tension, fostering assertiveness, enriching couples' communication, and dealing with separation and divorce are also offered. A policy of strict confidentiality is maintained concerning information about each student's contact with the CAPS staff. Individual evaluation and brief counseling/therapy as well as career and skills development seminars are covered by student health fees. There are no additional charges to the students for these services. Appointments may be made by calling 684-5100 or visiting CAPS, 214 Old Chemistry Building.

Academic Procedures and Information

Registration

All students enrolled in the Fuqua School of Business must register each semester until all degree requirements are completed. After receiving notification of admission to the school and returning a statement of acceptance of admission, the student must register for the term indicated in the admission letter. New matriculants register during orientation week at the designated times. Each student must complete a course card listing the course work to be taken during the semester. In the case of independent studies, courses outside the school and overloads, it will be necessary to obtain the permission of the program director. The student then presents this course card to registration officials for enrollment in the selected courses. After the first registration, a student must register for subsequent semesters at the regular stated time for registration. Currently enrolled students who fail to register at the first scheduled registration period for the subsequent semester incur a penalty for late registration.

Late Registration. All students are expected to register at the times specified by the University. A late registration fee of $25 is charged any student registering late.

Change of Registration. During the first *week* of the semester, registration may be changed with approval.

Academic Requirements for the M.B.A. Program

Grading. The grading scale for M.B.A. students is: Superior (*SP*)—4.0; High Pass (*HP*)—3.5; Pass (*P*)—3.0; Low Pass (*LP*)—2.5; and Fail (*F*).

Continuation Requirements. An M.B.A. student is expected to complete all courses approved by his/her Program Director for a given semester and attain a GPA of 3.0 to proceed to the next semester of the program.

Any student who receives a grade of fail (*F*), or a grade point average of less than 3.0 after any term, will be subject to academic performance review. The student's academic standing is determined during his/her performance review by the respective Program Director and the faculty of the Curriculum Committee. Any mitigating circumstances that may have inhibited a student from making satisfactory progress will be heard and evaluated at that time.

In order to be certified as making satisfactory progress toward the degree, a student enrolled in the M.B.A. program must:

1. Complete all courses approved by his/her Program Director for a given semester and attain a GPA of 3.0 or: have been reviewed by the Program Director and faculty of the Curriculum Committee, where it must be determined that mitigating circumstances did inhibit the student from meeting all course requirements or attaining a 3.0 GPA. Under these circumstances the student will be allowed to continue the program with a GPA below 3.0 and still be considered as making satisfactory progress toward the degree.
2. Complete the program according to the following schedule: a minimum of 33 credits in the first academic year of the program, and 63 credits by the end of the second academic year of the program.

For students enrolled in the Executive M.B.A. Evening Program, they must complete a minimum of 10 units by the end of the first calendar year, 34 units by the end of the second calendar year, and 50 units by the fall of the third calendar year.

For students enrolled in the Executive M.B.A. Weekend Program, they must complete a minimum of 27 units by the end of the first calendar year and 45 units by the fall of the second calendar year.

Students on official leaves of absence from any program will be exempted from these requirements for the duration of that leave.

Graduation Requirements. An M.B.A. student who has successfully completed all program requirements and has earned a grade point average of at least 3.0 will be graduated.

Exemptions. Students seeking an exemption from any course, curricular requirement, or other requirement of the Fuqua School of Business must submit a formal request to the Director of the M.B.A. Program. Exemption from a required course may be secured by passing an exemption examination in the subject matter of that course. In the case of an exemption, an elective must be substituted.

Standards of Conduct. Duke University expects and will require of all its students' cooperation in developing and maintaining high standards of scholarship and conduct. The University wishes to emphasize its policy that all students are subject to the rules and regulations of the University currently in effect or which are put into effect from time to time by the appropriate authorities of the University.

Any student in accepting admission indicates a willingness to subscribe to, and be governed by, these rules and regulations and acknowledges the right of the University to take such disciplinary action, including suspension and/or expulsion, as may be deemed appropriate, for failure to abide by such rules and regulations or for conduct adjudged unsatisfactory or detrimental to the University.

The Fuqua School of Business has established its own Honor Code which is overseen by a Judicial Board comprised of three faculty and three student members. The Honor Code governs conduct and the integrity of student scholarship.

Commencement

Graduation exercises are held once a year in May. At this time degrees are conferred and diplomas are issued to those who have completed requirements by the end of the spring semester.

Those who complete degree requirements at the end of the fall semester or by the end of a summer term receive diplomas dated December 30 or September 1, respectively. There is a delay of about one month in the mailing of September and December diplomas because diplomas cannot be issued until they are approved by the Academic Council and the Board of Trustees. A special conferring of degrees for executive M.B.A. students is held each year in October.

Other Information

Student Records. Duke University adheres to a policy permitting students access to their student records, with the exception of confidential letters of recommendation received prior to January 1, 1975, and certain confidential financial information. Students may request review of any information which is contained in their student records and may challenge the content of their records by appropriate procedures. An explanation of the complete policy on student records may be obtained from the Associate Registrar.

No information contained in student records (academic or otherwise) is released to persons outside the University or to unauthorized persons on the campus, without the consent of the student. A student grants consent by signing a form which authorizes the release of data. Specific consent is required for the release of information to any person or organization outside the University, and it is the responsibility of the student to provide the necessary authorization and consent. Official transcripts may be sent to the University Registrar at the signed request of the student and upon receipt of a $1 processing fee.

Reciprocal Agreements with Neighboring Universities. Under a plan of cooperation between Duke University and the University of North Carolina at Chapel Hill, the University of North Carolina at Greensboro, North Carolina Central University in Durham, and North Carolina State University at Raleigh, students properly enrolled in the Fuqua School of Business during the regular academic year, and paying full fees to this institution, may be admitted to a maximum of two courses per semester and four courses total at one of the other institutions in the cooperative plan. Under the same arrangements, students in the graduate schools in the neighboring institutions may be admitted to course work at Duke University. All interinstitutional registrations involving extra-fee courses or special fees required of all students will be made at the expense of the student and will not be considered a part of the Duke University tuition coverage.

Identification Cards. Graduate students are issued Duke University identification cards which they should carry at all times. Students must validate the card each semester by obtaining a semester enrollment sticker from the Registrar. The cards are the means of identification for library privileges, athletic events, and other University functions or services open to them as University students. Students will be expected to present their cards on request to any University official or employee. The cards are not transferable, and fraudulent use may result in loss of student privileges or suspension. A student should report the loss of a card immediately to the Registrar's office. The cost of a new identification card is $5.

Courses of Instruction

Master of Business Administration

CORE COURSES—300 SERIES

These courses are required to be taken in the first year except for Business Policy and the Management Experience (BA 340) and one course in the environmental field (one of BA 302, BA 342, or BA 345), which are typically taken in the second year. Students passing exemption exams may substitute electives in their first year. Unless specified otherwise, each course is worth three units of credit.

300. Managerial Economics. Considers how the actions of business firms, consumers, and the government—operating within a price system in a decentralized market economy—answer such basic resource allocation questions as what will be produced, how it will be produced, who will consume what is produced, and what resources to divert from present consumption to increase future consumption. The impact of various types of market structures (such as perfect competition, monopoly, and oligopoly) on economic efficiency will be discussed. Provides the student with an ability to view resource allocation problems within a constrained optimization framework and with some practice in applying marginal analysis.

301. Economic Environment of the Firm. Develops the theoretical framework within which the determinants of economic aggregates such as gross national product, the rate of unemployment, and changes in price levels can be analyzed. The emphasis of the course is to provide the manager with the knowledge necessary for making and understanding forecasts of the macroeconomic environment. Both Keynesian and monetarist approaches are considered.

302. The Economics of Government Policy toward Business. Provides the student with an understanding of how the firm interacts with other institutions in the economic environment. By examining both the theoretical and institutional framework of regulation, antitrust activities, and labor unions, the prospective manager will be better prepared to interact with noncorporate organizations. In addition, the course seeks to examine the role of the firm in the economy and the way in which it carries out its activities. Prerequisite: second-year standing in the M.B.A. program or consent of instructor.

303. Microeconomics for Managers. Provides an alternative to BA 300 for those students with intermediate or advanced backgrounds in mathematics. Both courses address the same topics. They develop the students' ability to apply economics to understanding the market environment in which managerial deci-

sions are made and provide a structure for the managerial decision-making process. Prerequisites: intermediate or advanced knowledge of business mathematics.

311. Statistical Analysis for Management. Examines structures for managerial decision making under conditions of partial information and uncertainty. After developing a foundation in probability theory, the course extends this foundation to a set of structures and methodologies for the analysis of decision problems. Included are topics in probability, classical inference, and multivariate analysis.

312. Quantitative Analysis for Management. Examines the principles and techniques of building quantitative models to aid managerial decision making. Special emphasis is placed on utilizing models for structuring and analyzing resource allocation problems and decision problems under uncertainty. Topics include linear programming, decision analysis, and simulation.

318. Computer Laboratory. Introduces the student to the personal computer as an aid to executive decision-making. The course covers the operation of the personal computer, and the use of software including electronic spread sheets, statistical analysis, and word processing. 1 unit.

320. Organization Behavior. Provides a study of organizations and their environment and the social and psychological foundations necessary to understand the behavior of individuals within organized settings. Emphasis is given to managerial strategies which enhance organizational effectiveness. Topics include individual and small group behavior, goal setting and adaptation, organization structure, and leadership.

330. Financial Accounting. Introduces the student to the types of information requirements imposed on the firm by agencies in its environment and develops an understanding of the activities of the firm within the framework of a financial accounting system designed to satisfy these information requirements. Emphasis is given to the study of financial accounting, reporting, and measurement problems from a theoretical and an applied basis, using cases and topical problems in financial accounting as a foundation for the learning experience.

331. Managerial Accounting. Focuses primarily on managers who are users rather than preparers of accounting information. Examines the use of accounting information in its major functions of planning, control, and product costing. Specific topics include cost estimation, budgeting, standard costing, control and performance evaluation, cost allocation, information systems, data limitations, and rational decision making using accounting information.

340. Business Policy and the Management Experience. Enables the student to apply the skills obtained in earlier courses to managing a business enterprise. The first portion of the course deals with issues like competitive analysis. In the course's second portion, student teams are responsible for the management of firms in a computerized simulation which has the characteristics of a large, consumer-oriented industry. Emphasis is placed on developing an overall corporate strategic plan, implementing the strategy, and communicating the plan and results to boards of directors. Decisions must be made concerning the fundamental areas of operations, marketing, finance, and human resource management. These decisions are made in light of the strategic objectives set forth in the plan. Each firm makes several formal oral and written presentations to its board of directors which is composed of faculty and executives from the local business community. The use of personal computers for analysis and report preparation is encouraged.

342. Social, Legal, and Political Environment of the Firm. Examines the social, legal and political environment within which the business firm exists and

must function. Issues of ethics, values and corporate culture are probably the least studied subjects in the formal training of entrepreneurs and executives. Class discussions explore issues raised by society's expectations of the corporation as well as corporate responses to these expectations. The course is organized around films, case discussions, guest speakers and lecture discussions. Recent topics have involved business ethics, public perception of business, business-media relationships, product safety and liability, corporate philanthropy and volunteerism, employment at will, the regulatory climate of business, political action committees and the ethics of advertising.

345. Legal Environment of the Firm. Considers the legal environment of the firm with emphasis on the legal system, the process by which laws are formulated and changed, and the type and forms of legal constraints imposed on firms. Also examined are major legislation, court cases, and regulation by federal agencies which affect the firm's decisions. Prerequisite: second-year standing in the M.B.A. program or consent of the instructor.

350. Financial Management. Provides an overview of corporate finance, financial markets, portfolio diversification and asset pricing. Since firms must understand financial instruments and how the market views them before making decisions about which ones to use, fundamental issues and models of risk, return and asset pricing are presented. Exercises and cases require students to project short-term and long-term financial needs, value bonds and stocks, and critique capital budgeting techniques. Futures and options markets are introduced and students briefly manage portfolios of those contracts. Major corporate finance issues of debt and dividend policies are examined.

360. Marketing Management. Provides an overview of the marketing function in business firms by acquainting students with the fundamental issues and decisions involved in planning and managing marketing activities. Attention is given to the strategic marketing decisions of new product development, product policy, pricing, advertising and communications, marketing research, personal selling, and channels of distribution. Major emphasis is placed on developing an understanding of the underlying forces which influence marketing decisions, including buyer behavior, competitive marketing activity, organizational considerations, and governmental regulation.

370. Operations Management. Surveys issues in the design, operation, and control of the process by which goods are manufactured and services delivered. Specific topics of study include the analysis of different kinds of production processes, managing the workforce, planning production and managing materials, managing quality, choosing new capacity, dealing with technological advance, dealing with vertical integration, and combining operations choices into a coherent strategy.

388. Business Communications. Constitutes a program in oral and written communication. It helps students develop the abilities to organize clearly and present effectively both written and oral reports. Oral practice is accomplished in the fall term, while written practice is a spring term endeavor. 2 units.

ELECTIVE COURSES—400 SERIES

These courses are typically taken by students with second-year standing but may be taken earlier with permission of the instructor. These courses are generally offered each year, but there may be additions or deletions in response to student and faculty interest. Unless specified otherwise, each course is worth three units of credit.

410. Operations Research Applications. Deals with problems of organization for an operations research project, formulation of the problem, model construction,

interpretation of analytical results, and implementation. Selected cases of particular applications of operations research from the literature serve as a basis for much of the class work. Students work in local industry, the University, the Medical Center, or in other cooperating agencies on operations research problems. Methodologically, some attention is devoted to advanced solution techniques as necessary to complete student projects, but primary attention is focused on formulation and use of models, the modification of existing models, or the development of new ones.
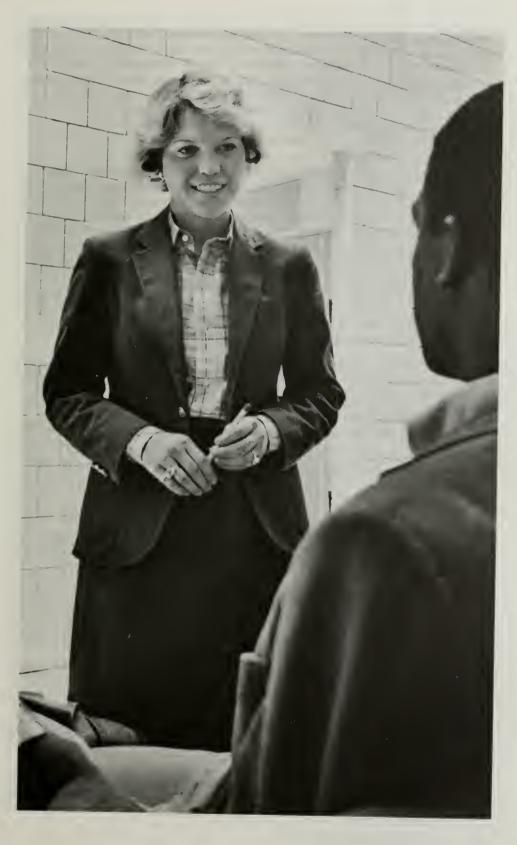
411. Operations Research Methods. Surveys the methodologies of operations research and shows how they can be applied to decision-making situations. The course will be primarily concerned with selecting which tool to use in various situations, rather than algorithm details. Topics to be covered include dynamic programming, stochastic programming, integer programming, nonlinear programming, Markov chains, inventory theory, and linear model formulation.

412. Statistical Forecasting. Increased access to computer data bases and modeling tools presents the modern manager with opportunities and challenges to use statistical data analysis in forecasting, planning, and decision-making. This course will cover the use of major statistical forecasting techniques, including multiple-regression and time-series models, that are applicable in many functional areas of business. It will emphasize hands-on computing with a microcomputer statistics package.

422. Dynamics of Bargaining. Explores the processes of bargaining and negotiation; the dynamics of interpersonal and intergroup conflict; and understanding of theory and research related to processes of influence, negotiation, and conflict management. A second part will emphasize skill development through extensive case analysis, role playing, and simulation.

423. Human Resource Management. Provides an integrative and comprehensive understanding of issues and challenges involved in the management of human resources in contemporary, complex organizations. The topics discussed include employee selection and placement, training and development, compensation and reward systems, performance evaluation, career development, and human resource planning. The legal context of human resource practices is also addressed. Perspectives for this course are from the line or operating managers primarily. The role of the personnel department and the personnel specialists is evaluated in terms of their contribution to the human resource function within the operations of the line manager.

424. Managerial Effectiveness. Explores what is known about effective management and leadership in organizations, and helps prospective managers identify and improve their own leadership skills. To achieve these purposes the course will alternate between a review of past research on organizational leadership and practical skill development. Readings and class discussion will provide exposure to various models of effective managerial behavior. In addition, much of the class time will be structured so that students will have an opportunity to experiment with, observe, and practice the skills being considered. Some of the topics reviewed include leadership style, organizational politics, interviewing, setting objectives and appraising performance, planning and time management, improving group effectiveness, and conflict management. Prerequisite: second-year standing in the M.B.A. program or consent of instructor. 3 units.

425. Managerial Decision Making. Focuses on helping managers to understand and improve decision making. The primary objective is the development of skills in the use of decision aids that exploit the intellectual strengths of humans while overcoming their cognitive limitations. Of particular interest will be the

techniques of decision analysis and the computer-based technology of decision support systems. Case discussions, experiential exercises, as well as lectures, will be used to help develop an appreciation of the potentials of various decision aids. Prerequisite: second-year standing in the M.B.A. program or consent of instructor. 3 units.

426. Organizing Business Activities. Organizing individuals' activities and decisions to perform tasks, solve problems, and achieve goals in business. Choices on the patterns and relations in people's activities and decisions that coordinate and control people to produce desired ends are studied. Different kinds of organizing decision problems and their relations to one another are identified and analyzed. The efficiency and effectiveness of the part or the whole of the organization that results from these decisions are analyzed for different environments. Organizing problems of divisionalized, matrix, functional, and other organizations are investigated. Organizing problems of departments, project teams, sections, and smaller units are also studied. The object is to understand the nature of the problems of organizing so that the solutions that emerge match the part or the whole of the organization to its goals, and to make both these fit the internal and external environments. The work includes readings, cases, and examinations of actual contemporary organizing problems and decisions. This course is intended for the student who is interested in getting it together, making it happen, writing the playbook, and staying with it. Prerequisite: second-year standing in the M.B.A. program or consent of instructor. 3 units.

427. Industrial Relations. Introduces students to the concept of an industrial relations system and the constraints that the choice of such a system places on a manager. The course begins with an in-depth analysis of the traditional North American unionized system, moves through the means by which this system is presently evolving, and concludes with a survey of some alternative systems. This course uses a union model as a means of introducing issues relevant to all industrial relations systems.

428. Managing Change and Innovation. Managing innovation, new technology, new product development, and research in the changing enterprise. Topics include the management of project selection, project implementation, manpower and resource allocation among competing activities, budgeting, productivity measurement and enhancement, conflict and coordination among organizational subunits, adaptive organizational forms, devising incentives and reward schemes for engendering new ideas, and risk taking. The course will use a combination of readings, lecture/discussions, cases, and guest lectures by managers. Students are encouraged to do field studies. Prerequisite: second-year standing in the M.B.A. program or consent of instructor. 3 units.

430. Financial Accounting Standards and Analysis I. Examines problems of asset and liability valuation and the related issues of income determination from the perspective of the professional accountant. The information needs of financial statement users are emphasized. Frequent reference is made to professional accounting pronouncements. Prerequisite: M.B.A. standing, one course in financial accounting, and one course in managerial accounting.

431. Financial Accounting Standards and Analysis II. Considers issues regarding ownership equities and the related problems of income determination from the perspective of the professional accountant. Specific attention is devoted to the accounting and reporting problems of complex corporate enterprises. The course emphasizes the information needs of financial statement users. Frequent reference is made to professional accounting pronouncements. Prerequisite: BA 430.

433. Management Planning and Control. Examines recent developments in the use of managerial accounting information with regard to the areas of manage-

ment planning and control. Advanced topics will be approached from an applications orientation.

434. Corporate Financial Reporting. Focuses on significant issues of interest to users of publicly available accounting information, including financial statements. Issues of current interest in the valuation of assets and liabilities and income determination are considered. Emphasis is placed on the effects of alternative accounting measurement and reporting procedures on users' decision models.

435. Management Information and Control Systems. Focuses on the set of problems associated with the design and operation of the information systems necessary to support strategic planning of an organization and to support the organization's control system. Specific attention is given to the role of information in planning and control, the economics of information, the dynamics of information flows, technologies of information systems, information system design, data base construction and maintenance, and reporting systems.

436. Internal Control, Auditing, and Information Systems Analysis. Studies the techniques available to evaluate the reliability of an existing information techniques available to system. An evaluation is made of information flows, aggregation techniques and other topics necessary to evaluate the credibility of information reported from a particular data gathering system. Topics include audit objectives from an internal and external standpoint, cost of information, standards, and other topics relevant to both internal and external auditing problems.

437. Financial Statement Analysis. Explores the use of financial statement information within the context of modern finance and accounting research. Empirical studies are introduced to demonstrate how financial statement data interface with nonaccounting data such as stock prices, industry factors, and macroeconomic variables. Major topics include the statistical properties of accounting numbers in time-series and cross-sectional analyses, the role of financial statement information in efficient capital markets and in portfolio decisions, and the association between accounting numbers and security returns. The course also examines financial information used in credit granting decisions and in predicting bond ratings and bankruptcy.

440. Corporate Strategy and Public Policy. Examines the major phases of the strategic planning process in business firms and the manner in which business firms can affect public policy. Considerations involving the various functional areas of management are synthesized to permit executives to make meaningful decisions concerning the product-market posture of the firm. Examples of the topics covered include formulation of goals, analysis of the external environment, bottom-up and top-down planning, coordination and control, management objectives and responsibilities, and the role of business firms in influencing public policy.

442. Entrepreneurship and New Venture Management. Provides an intensive, tutored field study of the formation of new business ventures. Students work in teams to develop market, strategic, operations, and financial aspects of original ideas toward completion of a full business plan. Entrepreneurs and new venture investors advise students on the progress of their work and evaluate final plans.

445. Business Planning. Presents corporate, security, and tax issues for analysis and resolution through examining a series of problems involving common business transactions. The problems will include such topics as the formation of closely-held and public corporations, stock redemption, the sale of a business, merger and other types of combination transactions, and recapitalization, division, and dissolution of corporations.

446. Federal Income Taxation. Deals with the basic concepts of federal income taxation with emphasis on gross income inclusions and exclusions, deductions, credits, and computations of gain, loss, and basis upon dispositions of property.

450. Short-Run Financial Management. Examines the financial management and control of a firm's short-term assets and liabilities. Topics include cash management, collection and disbursement techniques, management of the firm's short-term investment/borrowing portfolio, cash forecasting, receivables management, and the management of the firm's bank relationships. Prerequisite: second-year standing in the M.B.A. program or consent of instructor. 3 units.

451. Long-Term Financial Management. Deals with the long-term financing and investment decisions of the firm. Special attention will be given to the valuation of corporate securities, capital structure theory and policy, capital budgeting, corporate planning models, and analysis of the firm's cost of capital. Prerequisite: second-year standing in the M.B.A. program or consent of instructor. 3 units.

452. Money and Capital Markets. Considers the structure and behavior of capital markets. The course includes a discussion of the institutional framework of the American capital market as well as the major international markets, although the emphasis is on the theoretical foundation for analyzing interest rates and funds flow in those financial markets. Included among the topics is an extended discussion of monetary theory, the term structure of interest rates, and the analysis of risk in financial markets.

453. Investment Analysis and Portfolio Management. Focuses on the problems of selecting individual security issues for investment and the construction, management, and performance evaluation of portfolios. Topics that are covered include the structure and operations of securities markets, the behavior of security prices, the analysis and valuation of various types of securities, and the implementation of portfolio and capital market frameworks and tools for analysis.

454. Management of Financial Institutions. Explores various ways in which management science techniques can be applied to the management problems of financial institutions, especially commercial banks. The course will examine several types of financial institutions, consider the role that they play in the American economy, and focus on the use of management science techniques for helping executives cope with planning, decision making, and control problems.

455. Futures and Options Markets. Focuses on the use of futures and option contracts in the financial management of corporations and the management of security portfolios. In the futures area emphasis is placed on interest rate futures, currency futures, and stock index futures. General pricing of agricultural futures is also studied as well as the use of agricultural and other contracts in diversifying security portfolios. In the options area, emphasis is placed on the use of stock options in the financial management of stock portfolios. Also, interest rate options and the use of option pricing models in the formulation of optimal option investment strategies are studied.

456. Corporate Finance. Provides a selective overview of both short-run and long-term issues in financial management. Topics include cash management, collection and disbursement techniques, cash forecasting, short-run financial planning, receivables management, capital budgeting under uncertainty, capital asset pricing theory and the cost of capital, dividend policy, and the capital structure decisions. Prerequisite: second-year standing in the M.B.A. program or consent of instructor. 3 units.

457. Entrepreneurial Finance: The Investment Decisions. Certain investment decisions undertaken by a business organization, big or small, may be regarded as being truly entrepreneurial in the sense that the decisions have significant

strategic implications, and that relevant information may be fragmentary, incomplete, or very uncertain. To illustrate such risky investment decisions, one might consider a proposal to change production technology, a proposal to enter a new market environment, or a proposal to locate facilities abroad. Such decisions tend to require significant resource commitments where the management of risk is critical to the success of a venture. Approximately the first half of this course will be conceptual in nature with the objective of designing an analytical framework for use in decision making. The second half of the course will be applications oriented with a series of case studies being used to explore this area of management activity.

458. The Microstructure of Securities Markets. Examines the operations of the markets for securities, emphasizing common stocks. Primary attention is given to the structural charateristics of a trading system, the market-making function of specialists and other dealers, the determinants of a stock's trading characteristics (bid-ask spread, price volatility, and correlation patterns in returns), and the development of a National Market System. Major considerations in the design of trading systems that will be considered include competition in market making, integration of the marketplace, continuous markets versus periodic calls, automation of the trading process, stabilization of price movements, and regulation of securities markets.

460. Advanced Marketing Strategy. Considers in greater depth the process of strategic planning in the marketing function and its relation to corporate strategy. Offers an opportunity to sharpen and extend analytical skills in marketing as well as to synthesize understanding of the managerial, organizational, and environmental aspects of marketing activity.

461. Marketing Research. Considers the process of identifying and generating information from research as input to marketing decision making. Emphasis given to the perspective of the marketing manager in determining whether additional information is needed and, if so, how appropriate information should be acquired. Topics include problem definition, research budgeting, research designs (survey, observational, experimental), sampling, methods of data collection, data analysis, and interpretation.

462. Consumer and Buyer Behavior. Provides an opportunity for advanced study of the behavior of buyers of consumer and industrial goods/services. Objectives include (1) increasing the prospective manager's sensitivity to and understanding of buyers and the psychological, sociological, and anthropological forces which shape their behavior, and (2) enabling the student to apply this knowledge in arriving at improved marketing decisions.

463. Advertising Management. Deals with issues and problems in planning and controlling advertising activities in the firm, largely from the perspective of product managers and general marketing managers who must develop strategies for communicating with customers and other important publics of the firm. Attention is devoted to the setting of advertising objectives, budget appropriation, copy/message strategy, media strategy, advertising research and evaluation, and government regulation. Emphasis is placed upon behavioral analysis of target audience utilizing social-psychological and communication theories.

464. Product Management. Develops further insights into the process and policies which guide the firm's offering of products to the market place. Topics include the problem of merging market needs with corporate resources; product concept and positioning; systematic approaches to new product development; branding; packaging; product abandonment. The basic point of view is strategic in that product decisions are an integral part of overall marketing strategy decisions. Interfunctional management aspects are also considered.

465. Industrial Marketing. Provides students with the conceptual foundations and analytic techniques used in marketing products and services to businesses. Marketing issues are approached through complementary industry and firm analyses. An industry analysis characterizes the economic forces driving relationships among competitors, suppliers, and customers. Within the context of the industry, the appropriate strategy for the firm is determined. In addition to cases and readings, students are expected to complete one industry analysis using largely library sources. Following the industry analysis they are expected to write a strategic analysis of one firm within that industry.

466. Channel and Distribution System Management. Subjects of study are the formulation and solution of problems involving strategies and decisions on the firm's relations with other elements that make up its different market environments. Decision problems on the choice of forms and levels of cooperation and competition with other organizations are analyzed. The efficiency of different forms and structures of marketing channels and distribution systems is discussed and determined. Specific problems studied include: decisions on the allocation of marketing activities and resources to different levels and operations in the channel; the coordination of these activities and levels; the coordination and control of advertising, selling efforts, prices, etc. of sellers and resellers, and the various decisions on transaction components such as delivery time, credit terms, advertising allowances, managerial help, exclusive distribution and others. Lectures, discussions and cases.

470. Operations Planning and Control. Examines detailed tactical problems facing operating managers. The emphasis is on specific planning and control problems and on techniques for solving them. Topics include materials planning and inventory control, aggregate and detailed scheduling, and manufacturing software packages.

471. Manufacturing Strategy. Investigates the strategic operating policy options available to manufacturing companies, with the goal of learning why some companies' manufacturing operations are a greater competitive threat than others. The concept of factory focus will be examined in detail and aspects of the Japanese philosophy of manufacturing will be explored. The remainder of the course will take three different, and distinct, approaches to strategic issues. The first is an "industry" approach where different manufacturing strategies prevailing within a particular industry will be examined. The second is a "decision" approach where company handling of a specific type of decision (e.g., new capacity, vertical integration, process modernization) will be contrasted across industries. The third is an "external environment" approach where the impact on manufacturing of a particular external force (e.g., regulation, energy price inflation), will be assessed.

472. Operations Management in the Service Sector. Examines the strategic and tactical problems associated with the management of diverse service systems such as hospitals, banks, transportation companies, restaurants, and professional service firms. The course focuses on designing or improving service delivery.

473. Management of Technology. Examines the role of technological changes in improving productivity and in developing new products and services. The process of introducing new technology to the firm's production system is explored, along with issues in the management of research and development. Other topics include adaptation strategies, technology transfer, technology assessment/forecasting, and government policies toward technology and innovation. Organization contexts include manufacturing, services, hospitals and public agencies.

480. The International Environment. Examines the environment in which multinational firms operate. It includes a discussion of current policy issues such

as balance of payments, trade policy, and economic development. Special emphasis is given to the theory of the multinational firm and its role as a participant on the economic scene. That role is evaluated from the perspective of both the firm itself and the countries in which the firm operates.

482. International Finance. Provides the background necessary to recognize and analyze the financial problems facing a firm that operates in an international environment. This will be accomplished by developing a theoretical framework which describes the international environment and using that as background, studying specific financial problems related to multinational business.

490. The Practicum. Gives the student a significant experience in applying the concepts, theories, and methods of analysis learned in the program to a real, complex problem of an economic enterprise. It should include the analysis of a situation and the explicit formulation of a problem. The important task of identifying and specifying the problem is an integral part of the course. The practicum report should propose a solution to the problem and should contain the supporting explanation and logic. The solution should be one that can be implemented, not requiring unavailable resources. Prerequisite: second-year standing in the M.B.A. program and consent of the Director of the M.B.A. Program and instructor.

491.1–9. Special Topics in Management. Permits the study of special topics in management on an occasional basis depending on the availability and interests of students and faculty. Examples of special topics include project management, environmental regulation, transnational corporations, legal and tax aspects of entrepreneurship, and real estate finance.

499. Independent Study. Allows the student an opportunity to engage in a study of special topics on an individual basis under the supervision of a faculty member. Prerequisite: second-year standing in the M.B.A. program and consent of the Director of the M.B.A. Program and instructor.
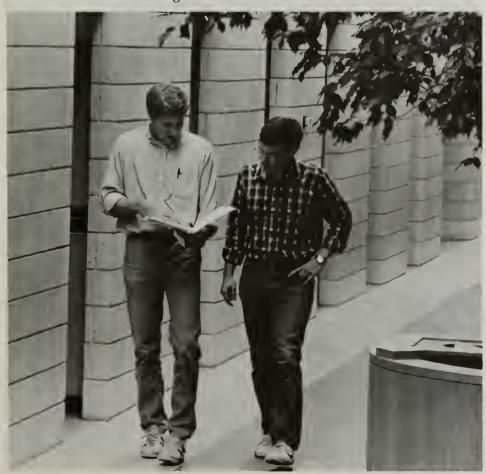
Doctor of Philosophy

These 500-level courses are available for Ph.D. students and qualified M.B.A.'s in the areas of accounting, marketing, operations management, finance, and organizational behavior. Typically one in each area will be offered each year. These courses are open to M.B.A. students desiring rigorous depth in an area with permission of the instructor. Unless specified otherwise, each course is worth three units of credit.

510. Bayesian Inference and Decision. This course focuses on methods of Bayesian inference and statistical decision theory, with emphasis on the general approach of modeling inferential and decision-making problems as well as the development of specific procedures for certain classes of problems. Topics include subjective probability, Bayesian inference and prediction, natural-conjugate families of distributions, Bayesian analysis for various processes, Bayesian estimation and hypothesis testing, comparisons with classical methods, decision-making criteria, utility theory, value of information, and sequential decision making.

531. Financial Accounting Seminar. Examines the nature of published financial statement information and its relationship with various economic variables. The list of related variables might include stock market data, bankruptcy filings, and the actions of various users of financial statement information, including management, investors, creditors, and regulators. The focus is on the current research methodologies and research efforts used to analyze the above relationships, as well as consideration of the underlying theoretical concepts. A background in masters-level accounting and finance is assumed.

532. Management Accounting Seminar. Examines information systems and their use in facilitating management decision making and organizational control. Emphasis will be placed on the appropriate research methodologies and paradigms including information economics, decision theory, and organizational theory. Topics include but are not limited to budgeting, incentive systems, performance evaluation, variance investigation, and cost allocation.

541. Organization Seminar—A Micro Focus. Focuses on individual and small group behavior in organizations. Theories of motivation, decision making, interpersonal behavior, group processes, and leadership are discussed. The course emphasizes a variety of research approaches and methods. The course will also include presentation of behavioral research by faculty members of the Fuqua School of Business and by other researchers.

542. Organization Seminar—A Macro Focus. Focuses on the organization and the subunits which make up the organization. Theories of organization, structure, decentralization, divisionalization, functional area integration, task design, incentives and rewards, information systems, and decision rules are discussed. These issues are developed with an orientation toward their choice and design for high performance. Throughout the course, there is an emphasis on appropriate research approaches and methods to investigate theoretical issues in various research settings. The course will also include presentation of research by faculty members of the Fuqua School of Business and by other researchers.

551. Corporate Finance Seminars. Introduces the student to research areas in corporate finance. The emphasis of the course will depend on the research interests of the instructor, with one or more of the following topic areas to be explored in depth: capital budgeting, capital structure, mergers and acquisitions, financing alternatives, dividend policy, valuation methods, cost of capital, international finance, and cash management.

552. Investment Seminar. Surveys research in the investment area and explores in depth one or more problems in which research is currently active. The emphasis will be determined by the instructor from one or more of the following areas: valuation of risky securities, capital asset pricing model and extensions, capital market efficiency, portfolio theory, options and warrants, investment management, microstructure of security markets, and futures contracts.

561. Seminar in Quantitative Research in Marketing. Presents an overview of the quantitative techniques which are important in marketing research. Each model and technique will be examined in considerable detail so as to permit an understanding of its assumptions, structure, and usefulness. Topics covered will include the general data analysis techniques as well as models from advertising, new products, and pricing decisions.

562. Seminar in Behavioral Models in Marketing. Examines the development of research in consumer behavior. Major emphasis is given to theoretical developments and empirical research with a range of articles assigned for each topic. Topics include motivation and personality, perceptual processes, information search, choice processes, attitudes and persuasion, learning, and influence in consumer choice.

571. Operations Strategy Seminar. Pursues the latest developments in the strategy of operations in both the manufacturing and service sectors. Topics include the focused factory concept, Japanese manufacturing philosophy, technological policy toward new process development and toward new product introduction, vertical integration, choice of capacity and location, industry analysis, and the impact of government regulation. The seminar emphasizes the development of hypotheses about strategic topics and the empirical means by which they can be tested.

572. Seminar in Operational and Technological Tactics. Examines current issues in the day-to-day management of manufacturing and service delivery systems. Topics include material requirements planning, capacity requirements planning, quality of work life projects, productivity measurement and enhancement, implementation of new product introductions and production process modifications, quality assurance, production planning and scheduling, and logistics. The seminar concentrates on (1) the substance of recent developments, (2) the generation and test of hypotheses about tactical issues, and (3) the applicability of various optimization techniques to the advance of operation tactics.

597. Dissertation Research. For students actively pursuing research on their dissertation. Prerequisites: student must have passed the preliminary examination and have the consent of the Director of the Doctoral Program and the instructor. Credit to be arranged.

598. Independent Study. Allows the doctoral student the opportunity to engage in study or tutorial on special topics on an individual basis under the supervision of a faculty member. Prerequisites: Doctoral Program standing and consent of the Director of the Doctoral Program and instructor. Credit to be arranged.

599. Directed Research. Allows the doctoral student to engage in individual research projects under the supervision of a faculty member. Prerequisites: Doctoral Program standing and consent of the Director of the Doctoral Program and instructor. Credit to be arranged.

Faculty

Faculty

The faculty of the Fuqua School of Business has developed a national reputation for both high quality teaching and research. One of the unique characteristics of this faculty is its diverse set of interests and professional backgrounds. Often an individual faculty member's interests will span two or three different areas of expertise. This diversity of interests ensures that the students will be exposed to wide-ranging views of the environment in which they will live and work after completing their educational experience.

The student-faculty ratio in the school is maintained at a level permitting development of close professional relationships and encouraging individual assistance in academic and professional relationships. Activities are planned which maximize student-faculty interaction. Some of these are career-related while others are more involved with research and teaching activities.

A brief description of the background and main areas of interest of the faculty follows:

Alison H. Ashton, Ph.D., *Associate Professor of Business Administration;* B.S. (Louisiana State University), M.P.A., Ph.D. (The University of Texas at Austin).

Professor Ashton's academic interests are in behavioral decision theory and accounting. Her published research includes studies of auditors as decision makers, as well as managers as users of accounting information. She has taught behavioral decision theory and auditing at New York University, and has also taught at the University of Texas at Austin and the University of Alberta. She currently serves on the editorial board of *The Accounting Review.*

Robert H. Ashton, Ph.D., CPA, *Professor of Business Administration and Area Coordinator for Accounting;* B.S. (Middle Tennessee State University), M.B.A. (Florida State University), Ph.D. (University of Minnesota).

Prior to joining the Duke faculty, Professor Ashton was on the faculties of New York University and the University of Texas at Austin, and he held a visiting position as the Winspear Foundation Professor at the University of Alberta. His principal research interest involves behavioral decision theory, especially as it relates to accounting and auditing issues. He also does research on the effectiveness and efficiency of external audits and other topics. He had published a book, a monograph, and numerous articles in leading journals, and he serves on various editorial boards.

Sheldon D. Balbirer, Ph.D., *Visiting Associate Professor of Business Administration;* B.S. (Carnegie Institute of Technology), Ph.D. (University of North Carolina at Chapel Hill).

Professor Balbirer's primary teaching interests are in the areas of corporate finance, corporate financial markets, and the management of financial institutions. His current research is centered on the rate structure of money and capital market instruments, as well as a number of projects relating to commercial bank management.

Helmy H. Baligh, Ph.D., *Professor of Business Administration;* B.A. (Oxford University), M.B.A., Ph.D. (University of California, Berkeley).

Professor Baligh joined the Duke faculty after teaching at the University of Illinois. His major research is in the analysis and design of economic structures for both business and social purposes. He has participated in the development of the Master of Business Administration programs at Duke and at the University of Illinois with emphasis on curriculum. His publications include *Vertical Market Structures* (with Leon E. Richartz) and several articles in the areas of transportation, hospital administration, marketing, economics, and organization structure design. He teaches in the fields of marketing, economic decision making, and organization design.

Joseph Battle, Ph.D., *Associate Professor of Business Administration;* B.S. (North Carolina Central University), M.S., Ph.D. (University of Michigan).

After serving as Special Assistant to the President of Shaw University, Professor Battle joined the Duke faculty, teaching in the areas of mathematics, probability and statistics, and economics. Research and consulting interests include the evaluation of federally funded poverty agencies with the Research Triangle Institute and local Durham organizations.

James R. Bettman, Ph.D., *Burlington Industries Professor of Business Administration, Director of the Ph.D. Program, and Area Coordinator of Marketing;* B.A., M.Phil., Ph.D. (Yale University).

Prior to joining the Fuqua School of Business, Professor Bettman taught at the Graduate School of Management, University of California, Los Angeles. He is the author of *An Information Processing Theory of Consumer Choice* as well as numerous articles in academic journals. Professor Bettman has also served as a consultant to government agencies, as a member of editorial boards of scholarly publications, and as a participant in numerous forums. He is currently coeditor of the *Journal of Consumer Research*.

William Boulding, *Assistant Professor of Business Administration;* B.A. (Swarthmore College), Ph.D. (University of Pennsylvania).

Professor Boulding is interested in model building relevant to managerial decision making, particularly in the area of advertising. His current research is concerned with using panel data on purchase and viewing behavior to better specify a media schedule for a firm. His teaching interests lie in the areas of advertising management and marketing research.

Douglas T. Breeden, Ph.D., *Associate Professor of Business Administration and Area Coordinator for Finance and Economics;* S.B. (M.I.T.), M.A., Ph.D. (Stanford University).

Prior to joining the Fuqua School of Business faculty, Professor Breeden taught at Stanford University, the University of Chicago, and M.I.T. Professor Breeden's teaching and research interests are in the area of investments, futures, and options. He has published in the major finance journals and is Associate Editor of the *Journal of Financial Economics* and the *Journal of Financial and Quantitative Analysis*.

Michele D. Bunn, Ph.D., *Visiting Assistant Professor;* B.A., M.B.A. (Michigan State University), Ph.D. (University of North Carolina).

Professor Bunn's primary research interest is the development of taxonomies of organizations and decision situations. Other research focuses on industrial organization issues related to marketing management problems and methods for qualitative research. She teaches product management and industrial marketing.

Marian C. Burke, Ph.D., *Assistant Professor of Business Administration;* B.A. (College of William and Mary), M.S. (Virginia Commonwealth University), Ph.D. (University of California, Los Angeles).

Professor Burke's teaching interests include marketing strategy and planning, competitive analysis, and product management. Her current research activities are focused on an examination of the decision rules used by marketing managers in selecting marketing strategies and on issues of advertising effectiveness.

Richard M. Burton, D.B.A., *Professor of Business Administration;* B.S., M.B.A., D.B.A. (University of Illinois).

Professor Burton's primary research interests are in the design and management of organizations. His research is concerned with the design of the firm for coordinated operations across the functional areas of marketing, strategy, production, finance, and information systems. He teaches courses in organization design, management of innovation and research, and corporate structure and planning. Recent consulting experience includes projects for Siecor and Bell Canada.

Jane L. Butt, M.S., *Assistant Professor of Business Administration;* B.A. (University of Florida), M.S. (University of Central Florida), Ph.D. (University of Michigan).

Professor Butt teaches managerial accounting. Her major research interests are in both the

cognitive and incentive issues related to individual decision making, including auditing and managerial accounting applications. Her dissertation research is titled, "Frequency Judgments in Auditing."

Kalman J. Cohen, Ph.D., *Distinguished Bank Research Professor;* B.A. (Reed College), M.Litt. (Oxford Univer sity), M.S., Ph.D. (Carnegie-Mellon University).
Prior to joining the Duke faculty, Professor Cohen served for two years as Distinguished Professor of Finance and Economics and as the first Director of the Salomon Brothers Center for the Study of Financial Institutions at New York University. He also spent fourteen years on the faculty of Carnegie-Mellon University's Graduate School of Industrial Administration. He has written seven books and over eighty articles in the areas of banking and finance, strategic planning, economics, management science, and computer simulation. He has pioneered in the applications of management science techniques in banking. His current research focuses on the microstructure of security markets.

Taylor Cox, Jr., Ph.D., *Visiting Assistant Research Professor;* B.S., M.B.A. (Wayne State University), Ph.D. (The University of Arizona).
Prior to joining the Fuqua School, Professor Cox spent nine years in management roles; six with the AT&T-Bell System and three in academic administration. He teaches courses in the management area including manufacturing strategy and organization theory. His current research centers on explaining upward mobility in large corporations and the use of contingency models for manufacturing decisions. Recent consulting involves the development of marketing plans in the health care industry.

Richard L. Daniels, Ph.D., *Assistant Professor of Business Administration;* B.A. (Northwestern University), Ph.D. (University of California, Los Angeles).
Professor Daniels' research interests concern the multiattribute nature of common problems in production and operations management. His current research considers the effects of a range of sequencing and resource-allocation decisions on the performance of closed scheduling systems. His teaching interests include operations planning and control, job shop scheduling, and project management.

Robert L. Dickens, M.S., C.P.A., *Professor of Accounting and Director of Undergraduate Studies;* B.S., M.S. (University of North Carolina).
Professor Dickens specializes in financial accounting and auditing. He has held offices in national organizations including Vice-President of the American Accounting Association and Chairman of the Committee on Education of the American Institute of Certified Public Accountants. He has served as consultant to the U.S. Office of Education and the U.S. Department of Agriculture on accounting and reporting matters. In 1966 he was awarded an honorary degree, LL.D., by Elon College.

Julie A. Edell, Ph.D., *Assistant Professor of Business Administration;* B.A. (University of Nebraska), M.S., Ph.D. (Carnegie-Mellon University).
Professor Edell's teaching interests are in the area of marketing, with emphasis on advertising, marketing management, consumer behavior, and marketing research. Her current research is concerned with examining the effect of advertising communications upon consumer purchase behavior. Her work has appeared in the *Journal of Consumer Research.*

John D. Forsyth, D.B.A., *Professor of Business Administration;* B.A. (Queen's University), M.B.A. (University of Detroit), D.B.A. (University of Illinois).
Prior to coming to Duke, Professor Forsyth was Professor of Business Administration and Director of the Program for Executive Development at IMEDE Management Development Institute in Lausanne, Switzerland. His teaching and research interests are in the areas of international financial management, the planning and control of capital investments, and the design of corporate strategies.

F. Douglas Foster, M.S.; *Instructor;* B. Comm. (The University of Alberta), M.S., Ph.D. anticipated 1986 (Cornell University).
Professor Foster is interested in financial intermediation, capital market theory, and international finance. His current research is in investment banking, the microfoundations of short term trading, and proxy fights and corporate control. He teaches investments and international finance.

John P. Gallagher, Ph.D., *Director, Computer Education Center;* B.A. (University of California, Berkeley), Ph.D. (University of California, Santa Barbara).
Professor Gallagher has extensive teaching experience in computer applications to education and problem solving. His research and teaching interests lie in the areas of computer application in support of managerial decision making, artifical intelligence and expert systems applications in management, and instructional psychology.

Grant W. Gardner, Ph.D., *Assistant Professor of Business Administration;* B.S. (Southern Methodist University), A.M., Ph.D. (Harvard University).

Professor Gardner's primary areas of research are macroeconomics and international economics. His current research interest is central bank policy in an open economy. He teaches macroeconomics and international trade.

W. Clay Hamner, D.B.A., *Adjunct Professor of Business Administration;* B.B.A., M.A. (University of Georgia), D.B.A. (Indiana University).

Professor Hamner teaches in the areas of organizational behavior, personnel management, and new venture management. He has published over thirty articles in the areas of bargaining strategies, applied motivation theories, equal employment opportunity, and predicting unionization. He has also consulted in these same areas for such companies as Sears, Marathon Oil Company, Clark Equipment, Pepsi, Chemical Bank, and the U.S. Savings Loan League among others. Prior to coming to Duke University, Professor Hamner taught at Indiana University and Northwestern University. Professor Hamner is the coauthor of six textbooks in the field of organizational behavior and personnel management.

Susan E. Heckler, Ph.D., *Visiting Assistant Professor of Business Administration;* B.A., M.B.A., Ph.D. (University of Minnesota).

Professor Heckler's current research activities examine visual and verbal processing, especially as related to consumers' processing of advertisements. Her teaching interests include consumer behavior and marketing and promotion management.

Joel C. Huber, Ph.D., *Associate Professor of Business Administration;* B.A. (Princeton University), M.B.A., Ph.D. (University of Pennsylvania).

Professor Huber came to the Fuqua School from the Columbia University School of Business and the Krannert Graduate School of Management, Purdue University. His teaching interests are in the areas of marketing and market research. He is a member of the American Marketing Association, the Association for Consumer Research, and the Psychometric Society.

Toby Y. Kahr, Ph.D.; *Lecturer;* B.S. (Columbia University), M.A., Ph.D. (University of Illinois).

Professor Kahr is Assistant Vice-President and Director of Duke University Human Resources. Before coming to Duke he served as Director of Personnel Services at the University of Illinois and worked for Ford Motor Company in personnel administration. Professor Kahr teaches courses in human resources management and industrial relations.

Thomas F. Keller, Ph.D., CPA, *R. J. Reynolds Industries Professor of Business Administration and Dean;* A.B. (Duke University), M.B.A., Ph.D. (University of Michigan).

Professor Keller specializes in accounting. His current research and teaching interests are principally in the areas of financial accounting and reporting. He has held several offices in the American Accounting Association, including Editor of the *Accounting Review* (1972–75). He is the coauthor and coeditor of several books in financial accounting. During the summer and fall of 1975 under the auspices of a Fulbright grant, he lectured in Australia and the Far East on a variety of topics related to the development of accounting theory and standards. He is currently a Director of Hatteras Income Securities, Inc., LADD Furniture, Inc., Pennwalt Corporation, and Southeastern Growth Fund, Inc.

Dan J. Laughhunn, D.B.A, *Professor of Business Administration and Area Coordinator for Quantitative Methods and Operations Management.* B.S. (Engineering Mechanics), M.B.A., D.B.A. (University of Illinois).

Professor Laughhunn has served as a consultant to industry and universities on a variety of topics related to planning and budgeting. His teaching and research interests deal with the application of quantitative techniques to problems in production and finance. Professor Laughhunn also has been actively engaged in teaching executive development programs, both at Duke and at other universities.

Arie Y. Lewin, Ph.D., *Professor of Business Administration;* B.S., M.S. (U.C.L.A.), M.S., Ph.D. (Carnegie-Mellon University).

Prior to coming to Duke, Professor Lewin was on the faculty of New York University for eight years. His research interests have been focused on applications of behavioral science to specific functional areas, organization design, person perception, and business participation in the formulation of public policy. Current research involves new approaches to measuring the effectiveness and efficiency of organizations and organization redesign, state owned enterprises in international trade, and the social, legal, and political environment of business. Professor Lewin is the coauthor of three books and his papers have appeared in numerous academic journals. Professor Lewin is the Organization Design Department Editor of *Management Science.*

Frederick W. Lindahl, *Assistant Professor of Business Administration;* B.S. (United States Air Force Academy), M.B.A. (Harvard University), Ph.D. (University of Chicago.)

Professor Lindahl spent several years in public accounting prior to joining Duke. Financial accounting is his primary research interest, his current research being an empirical probability model of selection of accounting principles.

John M. McCann, Ph.D., *Associate Professor of Business Administration;* B.S.M.E., M.B.A. (University of Kentucky), Ph.D. (Krannert Graduate School of Industrial Administration, Purdue University).

Professor McCann served on the faculty of the Graduate School of Business and Public Administration at Cornell and has been a consultant with an economic modeling and research firm. He is Director of the Marketing Workbench Laboratory. His teaching interests are in the areas of marketing and econometrics and information systems. His current research involves the interface between marketing management and computerized management information systems.

Kevin F. McCardle, Ph.D., *Assistant Professor of Business Administration;* B.S. (Marquette University), M.A., Ph.D. (U.C.L.A.).

Professor McCardle's teaching interests lie in the area of probability and statistics, linear and dynamic programming, game theory, operations research and sequential analysis. His research involves sequential decision theory, applications of game theory, models of R&D, and corporate strategy.

John M. McCracken, M.B.A., *Adjunct Professor of Real Estate Investment Analysis;* B.S. (East Tennessee State University), M.B.A. (Duke University).

Mr. McCracken is President of John McCracken & Associates, Inc., the largest real estate appraisal and consulting firm in the Carolinas, and President of McCracken Properties, Inc., a real estate development firm. He has taught real estate investment analysis courses for the Appraisal Institute at colleges and universities throughout the country. He authored the American Institute's seminar on "What to Look for in an Appraisal" and coauthored a portion of *North Carolina Real Estate for Brokers and Salesmen,* a text on "Land Economics."

Wesley A. Magat, Ph.D., *Associate Professor of Business Administration and Director of the Center for the Study of Business Regulation;* A.B. (Brown University), M.S., Ph.D. (Northwestern University).

Professor Magat teaches primarily in the fields of managerial economics and regulatory management. He is currently involved in research in the areas of toxic chemicals regulation, procedures and reform, and envorcement of environmental regulations. He serves as Director of the Duke Center for the Study of Business Regulation.

Steven F. Maier, Ph.D., *Adjunct Professor of Business Administration;* B.S. (Cornell University), M.S., Ph.D. (Stanford University).

Professor Maier is President and CEO of UAI Technology, Inc. and its University Analytics division. The company is based in the Research Triangle Park, N.C., and serves 200 banks and public utilities with its data products and computer models. Dr. Maier's research interests are in cash management and the microstructure of security markets. He is the author or coauthor of over forty journal articles and two books. He has also been active in Duke's executive development programs.

Joseph B. Mazzola, Ph.D., *Assistant Professor of Business Administration;* B.S. (State University of New York at Stony Brook); M.A. (Wake Forest University); M.S., Ph.D. (Carnegie-Mellon University).

Professor Mazzola's teaching and research interests are in the areas of production/operations management, management science, and operations research. His current research involves topics arising in operations scheduling, production and inventory control, and mathematical programming. Prior to coming to Duke, Professor Mazzola served on the faculty of the University of North Carolina at Chapel Hill.

Michael J. Moore, Ph.D., *Assistant Professor of Business Administration;* B.S. (Boston College), M.B.A. (Babson College), M.S., Ph.D. (University of Michigan).

Professor Moore's research interests are primarily in the areas of occupational safety and workers' compensation insurance. He also does research in marketing on the determinants of profitability and of industry structure. His teaching interests are in applied microeconomics, labor economics, and macroeconomics.

Richard C. Morey, Ph.D., *Associate Professor of Business Administration;* B.S. (Syracuse University), M.A., Ph.D. (University of California, Berkeley).

Professor Morey came to Duke with extensive business experience, having founded a management consulting firm and served as a consultant to many major businesses and governmental agencies. He has also been an Adjunct Professor at Stanford and George Washington Universities. He teaches in the areas of operations research and strategy. As Director of the Center for Applied

Business Research, he coordinates research efforts of the faculty related to government and foundation grants and contracts.

Thomas Mulligan, Ph.D., *Assistant Professor* (part-time); B.A. (Brock University), M.A., Ph.D. (Northwestern University).

Professor Mulligan's teaching and research are in the areas of computer-based manufacturing systems, the elements of corporate culture, and ethical issues in business. He has worked as an educator, manager, and consultant in the manufacturing and software industries and served as Visiting Assistant Professor of Philosophy at King's College.

J. Keith Murnighan, Ph.D., *Visiting Professor of Business Administration;* B.A., M.S., Ph.D. (Purdue University).

Professor Murnighan's research spans many aspects of bargaining and group decision making, and he has published articles in over a score of journals. His empirical research on game theory focuses on both the dynamics of competition and conditions that can increase cooperation. Currently his research continues explorations in the general area of group interaction and focuses on social dilemmas, the formation of norms, the dynamics and conflicts of intense work teams, and the development of effective techniques for problem solving and bargaining groups. Professor Murnighan comes to Duke from the University of Illinois and has also been a visiting professor at ESSEC in Cergy Pontoise, France and the University of Warwick.

Thomas H. Naylor, Ph.D., *Professor of Economics and Professor of Business Administration;* B.S. (Millsaps College), B.S. (Columbia University), M.B.A. (Indiana University), Ph.D. (Tulane University).

Professor Naylor has been a member of the faculty of the Department of Economics at Duke University since 1964. He is the author of 22 books and over 125 articles. Professor Naylor's consulting experience includes service to over 100 national and international organizations. He has lectured at universities throughout the world and is a member of several editorial boards. He is Director of the Center for Corporate Economics and Strategy at Duke.

Robert Nau, Ph.D., *Assistant Professor of Business Administration;* B.A. (University of California at San Diego), M.S., Ph.D. (University of California at Berkeley).

Subject probability theory, computer-based decision analysis, and time series forecasting are among Professor Nau's research interests. His articles have appeared in *Management Science* and *Journal of the Operational Research Society.* Prior to coming to the Fuqua School, Professor Nau taught at Tulane University and served as Manager of Information Systems at Liberty Mutual Insurance Company.

Richard B. Palmer, Ph.D., *Executive-in-Residence;* A.B. (Lehigh University), Ph.D. (The Johns Hopkins University).

Prior to joining the Fuqua School of Business, Dr. Palmer held the position of President of Texaco Canada, Inc. His thirty-two-year career with Texaco has included worldwide responsibilities.

John W. Payne, Ph.D., *Professor of Business Administration, Area Coordinator for Organizational Behavior, and Director of the Center of Decision Studies;* B.A., M.A., Ph.D. (University of California, Irvine).

Prior to coming to Duke, Professor Payne was on the faculty of the Graduate School of Business at the University of Chicago. His primary research activities deal with individual decision behavior. He has investigated decision making under risk, consumer choice behavior, and the design of computer-based support systems. He teaches courses in decision theory, organizational behavior, and consumer behavior.

David W. Peterson, Ph.D., *Adjunct Professor of Business Administration;* B.A. (University of Wisconsin), M.S., Ph.D. (Stanford University).

Professor Peterson's teaching and research activities are in the fields of mathematical modeling, statistical analysis, and operations research. His recent publications have dealt with control theory, portfolio selection, long- and short-range planning, and regulated utilities. He is a consultant to corporate and governmental litigation teams on matters pertaining to the structuring of statistically based legal positions.

Donna Rae Philbrick, Ph.D., *Assistant Professor of Business Administration;* B.S. (University of Oregon), M.B.A., Ph.D. (Cornell University).

Professor Philbrick is interested in effects of accounting information on the financial markets. Her dissertaiton is titled, "Information Processing and the Effects of Accounting Changes." She has published in the *Journal of Accounting Research.* Her teaching interests center on financial accounting at the elementary as well as the intermediate and advanced levels. Professor Philbrick taught at the University of Oregon before joining the Fuqua School faculty.

Christopher D. Piros, Ph.D., *Assistant Professor of Business Administration;* B.A., M.A. (Northwestern University), A.M., Ph.D. (Harvard University).

Professor Piros' research interests include portfolio theory, the structure of financial markets, and monetary economics. He teaches courses in investments, capital markets, and macroeconomics.

Robert E. Reinheimer, Ph.D., *Associate Professor of the Practice of Management Communication;* B.A., M.A. (California State University, Fullerton), Ph.D. (University of Kansas).

Professor Reinheimer came to the Fuqua School of Business from the University of Virginia. His primary areas of interest are in speech communication and small group communication. He has taught a number of courses and executive development programs in these areas, and he is responsible for the Management Communication courses in the M.B.A. and Executive M.B.A. programs.

William E. Ricks, Ph.D., CPA, *Associate Professor of Business Administration;* B.S. (University of New Orleans), Ph.D. (University of California, Berkeley).

Professor Ricks has had extensive teaching experience in both managerial and financial accounting in the M.B.A. program at the University of California at Berkeley. He holds a CPA certificate in Louisiana and has wide audit experience in oil, gas, and banking. His major research interest is financial accounting at both the individual and market level. His published research focuses on the stock market's reaction to accounting information.

Elaine Romanelli, Ph.D.,*Assistant Professor of Business Administration;* A.B. (University of California, Berkeley); M.B.A., Ph.D. (Columbia University).

Professor Romanelli teaches in the areas of organization behavior and new venture management. Her reseach interests include the strategies and processes of organization creation, and patterns of evolution for both new and large firms. She has published in *Management Science* and *Research in Organizational Behavior.*

Jeffrey L. Rummel, M.S., *Instructor;* B.A. (Capital University), M.S., Ph.D. anticipated June 1987 (University of Rochester).

Professor Rummel's teaching and research interests are in the areas of manufacturing and operations management, management science, and mathematical programming. His dissertation is titled, "Costs and Performance Measurement in Batch Manufacturing," and his other current research concerns automated scheduling and lot sizing systems.

James E. Sheldon, L.L.M. *Adjunct Assistant Professor of Business Administration;* B.A. (Dartmouth College), J.D. (University of California), L.L.M. (Boston University Law School), L.L.M. (University of Stockholm).

Before joining the Fuqua School of Business, Mr. Sheldon practiced corporate, securities, and tax law for seven years in Boston and San Francisco. His teaching and research interests include business and tax planning. He is a member of the California, Massachusetts, and North Carolina Bar Associations.

Blair H. Sheppard, Ph.D., *Associate Professor of Business Administration and Director of the Center for Human Resource Management;* B.A., M.A. (University of Western Ontario), Ph.D. (University of Illinois).

Professor Sheppard joined the Fuqua School of Business from the faculty of Management at McGill University. He teaches in organization behavior, personnel management, and industrial relations. His research interests include conflict resolution and group effectiveness. He has published in the *Journal of Personality and Social Psychology, Research in Organizational Behavior,* and *Journal of Applied Social Psychology.* His consulting has been in the area of human resource management.

Charles J. Skender, M.B.A., *Visiting Assistant Professor of Business Administration;* B.S. (Lehigh University), M.B.A. (Duke University).

C. J. Skender is a licensed DPA, CMA, CIA, and CCA. He has served as a training consultant for Wells Fargo Bank, and previously worked on the audit staff of Deloitte, Haskins & Sells. In 1985 he received an outstanding teacher award at North Carolina State University, where he is a member of the faculty. He teaches intermediate and advanced financial planning.

Richard Staelin, Ph.D., *Associate Dean for Faculty Affairs and Edward and Rose Donnell Professor of Business Administration;* B.S., M.B.A., Ph.D. (University of Michigan).

Prior to joining Duke's faculty, Professor Staelin served as Professor and Associate Dean at the Graduate School of Industrial Administration, Carnegie-Mellon University. He was also a Visiting Professor at the Australian Graduate School of Management and at the University of Chicago. His professional activities include consulting work for both the public and private sectors, active participation in professional associations, service on editorial boards of four academic journals, and publication of a book and over forty journal articles. He is presently Area Editor of *Marketing*

Science. Professor Staelin's current research interests include information search and channel management.

Jens A. Stephan, Ph.D., *Assistant Professor of Business Administration;* B.S.M.E. (University of Michigan), M.B.A. (Pennsylvania State University), Ph.D. (Cornell University).

Professor Stephan's teaching interests are in managerial and financial accounting. He has done research on the ability to measure the impact of firm-specific events on security prices, and his current research investigates the role of prices as a source of information for security market traders.

Sebastian Teunissen, *Visiting Assistant Professor of Business Administration;* B.A. (University of Guelph), M.A., Ph.D. (Duke University).

Prior to coming to Duke, Sebastian Teunissen was Assistant Secretary in the Department of Finance for the Government of Papua New Guinea. He has also been employed in the securities industry and has been on the faculties of both the University of Guelph and North Carolina State University. His current research concerns international securities transactions, and he teaches courses in financial management.

Anne S. Tsui, Ph.D., *Assistant Professor of Business Administration;* B.A., M.A. (University of Minnesota); Ph.D. (University of California, Los Angeles).

Professor Tsui teaches in organization behavior and human resources management. Her research interests focus on the effectiveness of managers and the human resource management function. She has published in the journals of *Organizational Behavior and Human Performance, Industrial Relations,* and the *Academy of Management Journal.* Her professional experience includes employment and consulting with Control Data Corporation.

James H. Vander Weide, Ph.D., *Research Professor of Business Administration;* B.S. (Cornell University), Ph.D. (Northwestern University).

Professor Vander Weide's primary research and teaching interests are in the areas of corporate finance and managerial economics. He has written papers on topics such as cash management, capital budgeting, portfolio analysis, and the economic effects of government regulation. He has also served as a consultant to banks in the area of cash management. He has testified as an expert witness on the cost of capital before the Public Utility Commission of several states.

S. Viswanathan, M.M.S., *Instructor;* B.Sc., M.M.S. (University of Bombay), Ph.D. anticipated in 1986 (Northwestern University).

Professor Viswanathan teaches corporate finance. He is interested in developing economic models to explain how corporations make their major financial decisions. His dissertation research is titled, "A Multiple Signalling Model of Corporate Finance."

Robert E. Whaley, Ph.D., *Associate Professor of Business Administration;* B. Comm. (University of Alberta), M.B.A., Ph.D. (University of Toronto).

Prior to joining the Fuqua School of Business faculty, Professor Whaley taught at Vanderbilt University, the University of Alberta, and the University of Chicago. He also served as Vice-President-Research with GNP Consulting in Chicago and as Director of the Institute for Financial Research at the University of Alberta. Professor Whaley's research interests are currently in the area of financial futures and options.

Robert L. Winkler, Ph.D., *Calvin Bryce Hoover Professor of Business Administration;* B.S. (University of Illinois), Ph.D. (University of Chicago).

Prior to joining the Duke faculty, Professor Winkler served as Distinguished Professor of Quantitative Business Analysis at Indiana University, and he has held visiting positions at the University of Washington, the International Institute for Applied Systems Analysis, Stanford University, and INSEAD. His primary research interests involve Bayesian statistics, decision analysis, risk assessment, and probability forecasting. Professor Winkler is the author of numerous research articles and books, is Departmental Editor for Decision Analysis for *Management Science,* and serves on the editorial boards of several other journals.

Edwin D. Wolf, M.S., *Executive-in-Residence;* B.S. (New York University), M.S. (Columbia University).

Mr. Wolf was a partner in the New York office of Peat, Marwick, Mitchell & Co. prior to joining the Fuqua School's faculty as Executive in Residence. His responsibilities involved the analysis, design, and implementation of systems and techniques for improving managerial and operational control of client organizations.

William L. Yaeger, J.D., *Adjunct Associate Professor of Business Administration;* B.A. (Duke University), J.D. (Emory University).
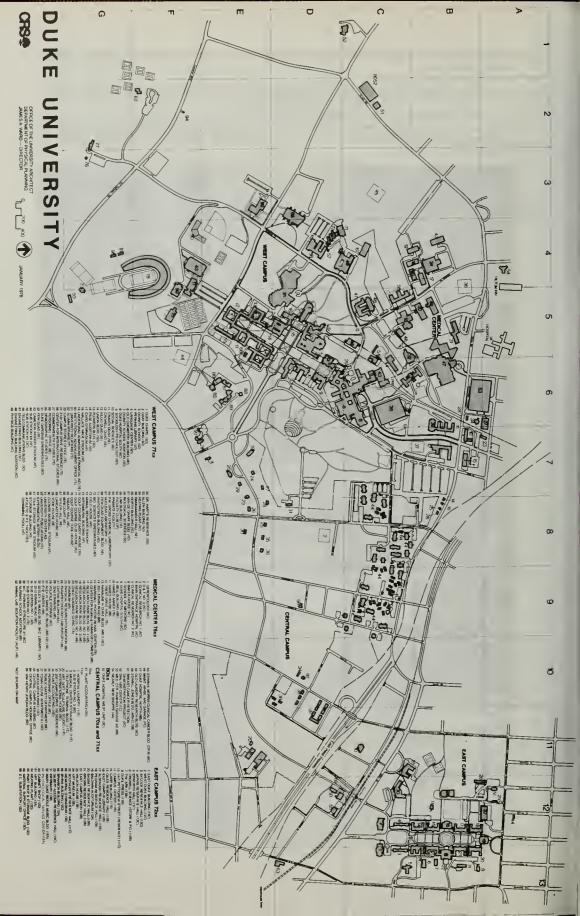
Mr. Yaeger teaches the course, Legal Environment of the Firm in the M.B.A. programs. He is in private practice in Durham, North Carolina, with an emphasis on bankruptcy and insolvency. Mr.

Yaeger is a member of the North Carolina Bar Association and the National Association of Bankruptcy Trustees.

Valarie A. Zeithaml, D.B.A., *Visiting Associate Professor of Business Administration;* B.A. (Gettysburg College), M.B.A., D.B.A. (University of Maryland).

Professor Zeithaml, who is visiting Duke for two years, has teaching interests in marketing strategy, services marketing, and advertising. Her current research interests include measurement of perceived quality, consumer response to price, and communication and control processes in the delivery of service quality.

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